Canadian International Food Security Research Fund (CIFSRF) - Contribution Analysis

Country Report

Scaling up small millet post-harvest and nutritious food products (IDRC project #108128)

India small millets

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Barnyard millet intercropped with other nutritious foods; farmer near a millet field; girl at a focus group of millet farmers Oct/Nov 2017

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The interpretations and opinions expressed in the report are, however, not necessarily those of the above mentioned, nor of the ODI or of IDA. The authors are solely responsible for any errors and omissions.

Acronyms and abbreviations

AP	Andhra Pradesh
CAD	Canadian Dollar
CIDA	Canadian International Development Agency
CIFSRF	Canadian International Food Security Research Fund
COM-B	Capacity, Opportunity, Motivation - Behaviour change
DHAN	Development of Humane Action
FAO	Food and Agriculture Organisation of the UN
FAOSTAT	FAO statistics database
FPO	Farmer Producer Organisation
FSSAI	Food Safety and Standards Authority of India
GIZ	German Corporation for International Cooperation
GST	Goods and Services Tax
HDL	High Density Lipoprotein (cholesterol)
IDA	Institute of Development Alternatives
IDRC	International Development Research Centre
k	Thousand
LDL	Low Density Lipoprotein (cholesterol)
M	Million
MOU	Memorandum of Understanding
MSSRF	MS Swaminathan Research Foundation
NGO	Non-governmental organisation
ODI	Overseas Development Institute
PAD	Project Approval Document
PDS	Public Distribution System
R&D	Research and Development
RESMISA	Revalorising Small Millets in Rain-fed Regions of South Asia
SM	Small millet(s)
SME	Small and Medium Enterprise
SUSM	Scaling Up Small Millets
TN	Tamil Nadu
TNAU	Tamil Nadu Agricultural University
ToC	Theory of Change

Executive Summary

This report reviews a project funded under the Canadian International Food Security Research Fund (CIFSRF) Phase 2, a jointly funded program of the International Development Research Centre (IDRC) and Global Affairs Canada. *Scaling up small millet post-harvest and nutritious food products*, or Scaling up Small Millets (SUSM), is a partnership of the Development of Humane Action (DHAN) in India, McGill University, Canada, and the Tamil Nadu Agricultural University (TNAU). This study aims to capture SUSM's contribution — and potential contribution — to food security

SUSM aims to help four main groups:

1) **Equipment manufacturers**, to promote manufacture and distribute small millet (SM) dehulling machines;
2) (Mostly small-scale) **food manufacturers** to (a) promote inclusion of more SM in snacks and ready-mixes, and (b) improve hygienic practices among enterprises selling SM foods;
3) **Farmers** to access dehullers, saving them time and reducing arduous hand-hulling traditionally done by women, allowing them to earn more from their millet, and potentially encouraging them to plant more millet.
4) **Consumers**, promoting consumption of SM.

SM have a long history of cultivation in India. As dryland crops, they are often grown as part of a risk mitigation strategy. Area under millet production and per-capita millet consumption has been declining in India, with both roughly halving from the early 1960s to recent years. Area and production of SM in Tamil Nadu State, the heart of this project, declined strongly from the early 1960s. There is however some indication of a comeback for a few varieties in recent years.

Key food security challenges identified by project implementers are threefold:

1. Triple burden of malnutrition — characterised by stagnating undernutrition in under-fives, widespread micronutrient deficiencies, and rising overweight and obesity
2. An increasing burden of non-communicable diseases (NCDs), including diabetes, cardiovascular and intestinal disorders, cancer
3. A decline in diversity of diets

SM are offered as solutions: for their superior nutritional content compared to other cereals, for their medicinal properties, and because they are grown in diverse cropping systems. The small-scale dehulling promoted also removes fewer nutrients than large-scale dehulling.

This study is based on two weeks of fieldwork by ODI and IDA Chennai; facilitated by DHAN Madurai and their partners in Tamil Nadu. Phone interviews and existing reports have supplemented the fieldwork. Key stakeholders consulted in the field included members of farmer producer organisations (FPOs), millet farmers, millet food producers, machine manufacturers, a women's federation leader, women's federation members, DHAN staff, and TNAU staff.

Overall this ambitious project has been well-conceived and executed. Testing the Theories of Changes (ToC) for equipment manufacturers, millet foodstuff producers, farmers, and consumers found that proposed activities were being carried out to good effect.

Equipment manufacturers' capacity to produce and sell dehulling machines has been significantly boosted, allowing companies to produce more equipment while employing more people.

Millet snack producers have benefited from assistance with their businesses and are incorporating more SM into their products, using more hygienic methods, while selling higher quantities. This improves the livelihoods of business owners and employees. Consumers of the SM products in question have the potential for improved health.

Farmers are in some cases using dehulling machines to process SM before selling it, achieving higher prices. Some women are also using the dehullers to process SM for home use, mostly those who live near the machines. This review did not find much evidence that the presence of dehulling machines was encouraging farmers to plant more SM, but this may reflect the limited sample.

Consumers have been encouraged to eat more SM, particularly large numbers of low-income consumers influenced via DHAN's women's federation in Salem. Families are consuming more varieties of SM more often. While it has not been possible to quantify the health impacts arising from people's increased consumption of SM, potential impacts exist, and some consumers self-report positive impacts.

SUSM scores highly on **sustainability**, and is run by a team whose dedication to SM extends beyond the CIFSRF timeframe. Millet foodstuff producers are predominantly existing businesses or businesses run by those keen to enter and remain in the SM market, seeing it as a growing business opportunity. Changes

occasioned by the project in these producers are likely to persist, while demand for millet products is on an upward trajectory. In Tamil Nadu State at least, farmers are already growing more finger millet. If demand continues to rise among consumers, and with expansion of small-scale processing units available, it is reasonable to expect farmers to continue to choose to plant SM: perhaps even to increase them. Many consumers appear to increasingly seek to (re)integrate SM more heavily into their diets.

To date the project has been successful in the **scale up** proposed, helping large numbers of micro- and small enterprises produce (healthier) millet products, improving sales of SM dehullers, and reaching large numbers of new consumers with SM as well as potential customers with information about SM.

Improved **nutritional status and health**, particularly for pre-diabetics, is expected where people are replacing traditional cereals such as rice with SM.

For farmers, choosing to produce more SM means retaining cropping systems that are diverse, potentially improving availability of other micronutrient-rich food among farm families.

Significant improvements to **incomes** of machine manufacturers, as well as millet foodstuff producers have been realised. In several cases, income boosts likely represent a significant share of household income.

For women who live within ready access to dehullers, drudgery in hand processing SM has been reduced through proliferation of small-scale mechanised processing units for SM.

Women have also been clearly targeted and supported through the project's support to micro- and small enterprises that are largely run by women (or in part by women). Capacity and opportunities of these women have been significantly boosted through SUSM.

The team assembled is exceptional, and highly complementary. The focus of McGill staff and students is on researching, developing, and analysing useful technologies and methodologies around millet and associated foods. At TNAU, which also carries out research, the technologies and techniques developed in McGill and TNAU research settings have been incorporated into practical training sessions. These include courses on how to prepare millet-based therapeutic foods; on processing techniques such as flaking, popping, baking. Finally, DHAN, with its wide reach on the ground, and strong advocacy and self-help experience acts as an interface between the science of McGill/TNAU and both the awareness and practical needs of target beneficiaries.

The focus of CIFSRF on influencing policy is one of its key strengths, and this project has successfully carried out an influential and strategic policy workshop. Through this exercise, SUSM has been able to identify several action points to overcome hurdles in millet production, processing, and consumption.

Small millets have arguably reached something of a crossroads. After decades of policy neglect, they are gradually emerging into the limelight, helped by undertakings like SUSM which boost awareness among consumers, producers, and policymakers alike.

Recent news reports that India's *Minister for Agriculture and Farmers Welfare* has sent a proposal to the UN asking for 2018 to be declared International Year of Millets — a clear signal of government commitment (Rava, 2017).

SM remain a relatively marginal crop in an agricultural economy that is declining in importance as India's economy develops. Nonetheless, there are plenty of reasons to be optimistic about the future of SM, as the considerable progress already made through this project has shown.

Overview

	Equipment manufacturers	Millet foodstuffs producers	Farmers	Millet consumers
Project activities, deliverables and results				
Theory of change	Support to equipment manufacturers allows them to make and sell (more) small millet dehullers	Support to (especially) micro and small enterprises allows them to make and market (more) millet products	Presence of dehullers near farms boosts millet consumption among farmers, reduces drudgery for women	Consumption of small millets increases in wider population with positive effects on their health
Activity	Manufacturers are supported with business development and marketing	Foodstuff producers are supported with business development and marketing	Dehullers are established in milling stations and farmer producer organisations near growing areas	Promotion through DHAN's women's federation, other media outreach activities
Changes to capacity, behaviour	Manufacturers are making and selling more dehullers	Micro and small enterprises are producing and selling more millet-based foods, under more hygienic conditions	FPOs are processing more small millet. Farmer uptake depends on proximity to the machines. Some indication some farmers are eating more millet. Some women are substituting machine hulling for hand-hulling of millet	Strong indication millet consumption is boosted through Salem women's federation, and through increased sales/inclusion of millet from MSE (see second column)
Results	Manufacturers incomes are improving, more staff employed on higher wages	Incomes for enterprises improve. Stimulates demand for farmers to produce small millet	Farmers achieve better prices by selling millet processed For women farmers living near to processing units, some drudgery has been reduced. Improvements to dietary diversity of farmers as millet is grown intercropped with diverse pulses and wild greens	Consumers view of millet-based foodstuffs improves Consumers feel health benefits of consuming millet
Impact	Improved welfare for manufacturers and staff through better incomes, stable work	Consumers less likely to become ill owing to unhygienic millet-based foodstuffs. Improved livelihoods for enterprise owners/ staff	Likely positive impacts on health of farmers and their families. Impacts on income not assessed	Consumers are healthier
Sustainability and scaling up				
Sustainability	High. Manufacturers have systems in place to guarantee functioning machinery	High. Consumer demand for millet, particularly among urban middle-class is rising	High — though dependent on many factors including prices of competing crops	High — see second column
Scaling up	Plenty of unmet demand for small-scale processing machines across India. Constant innovation by manufacturers.	Plenty of scope among existing enterprises to supply larger markets, diversify products (e.g. therapeutic products) Potential to replicate the model more widely. DHAN committed to further action on millets.	If increasing demand for small millets can be maintained, should incentivise farmers to produce more.	Strong potential to scale up further via inclusion of millets in public distribution systems, school feeding schemes.

Specific outcomes	
FSN	Improved nutrition expected through replacing traditional cereals such as rice with small millets that are higher in micronutrients. Promoting production of small millets promotes cropping systems that are diverse, potentially improving availability of other micronutrient-rich food among farm families.
Income	Strong boosts to incomes for machine manufacturers as well as micro and small enterprises. Income impacts for farmers are likely marginal (but not a focus of this project)
Sustainable agriculture	Millet is a low-input crop, traditionally produced in mixed cropping systems
Gender	Most of the micro- and small enterprises are owned or staffed by women, or run by women in collaboration with husbands. Reduction in women's drudgery from millet processing may not be as strong as initially thought; dependent on ease of accessing dehullers.
Contribution of CIFSRF project	
Capacity building	Active collaboration between DHAN, TNAU, and McGill University, generating research that would not have been possible without the partnership
Research contribution to policy or wider results	Policy workshops have been held to influence government positions with regard to millet. Contribution of this project is not clear, but state and national government appears increasingly favourable to small millets, particularly finger millet.

Colour coding:

Unsatisfactory: very little achieved	Some gains, but achieved less than expected	Some progress: about half of what was expected	Largely successful: most objectives achieved	Highly successful: all objectives achieved, in some cases by more than expectations

White: not assessed

1. Introduction

1.1 Purpose and aims

The Canadian International Food Security Research Fund (CIFSRF) was designed to address global problems of food and nutritional insecurity through applied, collaborative, results-oriented research. CIFSRF is a program of Canada's International Development Research Centre (IDRC) undertaken with the financial support of the Government of Canada, provided through Global Affairs Canada. Phase 1 (2009-2014) focused on testing innovations, while Phase 2 (2013-2018) aims to both test scaling up methods/mechanisms and to scale up practical solutions to: increase food production, raise income for farming families, and improve nutrition. The emphasis in Phase 2 was to harness the best of the private, public and not-for-profit sectors to expand CIFSRF's research portfolio so innovations reach more people and have a greater impact globally to improve food security.

CIFSRF set the parameters of the Phase 2 research projects by requesting certain similar elements, such as a need to have: a team of diverse partners (including at least one private sector or business partner, at least one Canadian partner and at least one developing country partner) in order to scale up pilot-tested agricultural innovations; a scaling up plan; a business model with a proof of concept and value proposition; a gender strategy; rigorous research plan and methodology to test the scaling up; policy uptake plan; as well as a comprehensive exit strategy. All projects needed to address the three cross-cutting themes of the program: gender equality, environmental sustainability, and good governance. While the projects were autonomous, the strategic calls allowed for a level of consistency across the projects

While 18 projects were funded as independent projects in CIFSRF Phase 2 through competitive calls, the projects received significant group training and capacity building from IDRC over their duration, including specific workshops and mentoring on: scaling up, research methodology, gender integration, communications, and monitoring and evaluation. The overall quality of the various project strategies (e.g. scaling strategy, gender strategy, etc.) was not consistent across projects, reflecting the variable capabilities in each project team. IDRC Program Officers provided specific support on the development and implementation of these strategies, through workshops and direct technical advice. The group workshops facilitated by IDRC also allowed opportunities for cross-project collaboration and the sharing of lessons.

This report concisely reviews one of the CIFSRF phase two projects . *Scaling up small millet post-harvest and nutritious food products*, also known as Scaling up Small Millets[2] (SUSM), is a joint endeavour led by the Development of Humane Action (DHAN) in India, in partnership with McGill University, Canada, and the Tamil Nadu Agricultural University (TNAU) in Coimbatore. This study aims to capture SUSM's contribution — and potential contribution — to food security, with particular reference to:

- sustainable **food production**
- people's **incomes** and ability to afford food
- people's **nutrition**

as well as two elements central to the CIFSRF endeavour:

- **sustainability** of current and further **scale up** — potential to capitalise on legacy of the project; for benefits to continue, expand, and multiply; and
- **gender** — especially any impacts on women's status and empowerment.

Part of a wider portfolio review of CIFSRF phase two projects, SUSM is one of six case studies purposively sampled for its likelihood of showing early impacts. This analysis forms one strand of a wider study of the contribution of CIFSRF's phase two portfolio to food security. Five sister cases are being prepared concurrently, looking at CIFSRF projects in Colombia, Ethiopia, India, Nepal, and Tanzania.

1.2 The project

SUSM was approved in December, 2015; a 27-month-long, CA$1.5M food security research and development project built around scaling up production of appropriate-size small millet (SM) processing machinery, as well as SM value-added products. The project aims to boost demand for millet and by focusing

[2] Small millets include millet crops with small grains (the project implementers prefer the term 'small' as opposed to 'minor', as the latter can seem pejorative). There are six main species cultivated: barnyard, foxtail, kodo, finger, little, and proso. These contrast to 'major millets' with larger grains: pearl millet and sorghum.

on two main points along the supply chain: production of small-scale millet processing machinery, and production of millet-based ready-prepared foodstuffs. Through working with small and medium-sized machine businesses to help them build and market SM dehullers, and with micro, small, and medium-sized food businesses to produce and market healthy small millet-based foods, SUSM aims to reach some 120k consumers, while creating a sustainable legacy.

General and specific project objectives defined by the project implementers are set out in Table 1.

Table 1 General and specific project objectives of Scaling up Small Millets

Objective		Description
The general project objective		To scale up small millet processing and value-addition technologies to reduce drudgery of women and improve nutritional security in India
Specific objective	1	To scale up the reach of dehulling and processing equipment and consumption of small millet food products.
	2	To test different business market development and service provision approaches across the small millet value chain to improve consumption of small millets in rural and urban areas.
	3	To inform key policy makers and other important stakeholders on the best practices and policy interventions needed for scaling up the adoption of small millets processing and value-addition technologies.
	4	To build awareness and capacity of end-users and consumers of small millet processing equipment and value-added millet-based food products.

Source: IDRC, 2015

SUSM builds on two earlier CIFSRF projects on SM: *Revalorising Small Millets in Rain-fed Regions of South Asia* (RESMISA), led by DHAN and the Canadian Mennonite University; and *Enhancing food security of rural families through production, processing and value-addition of regional staple food grains in India*, led by the University of Agricultural Sciences — Dharwad, MSSRF and McGill). Crucially, these earlier projects worked a) with farmers on SM variety selection; b) on engineering technologies in SM dehulling; and c) on recipes for SM foodstuffs — all captured in the scaling up efforts of SUSM.

Context and brief history

Small millets have a long history of cultivation in India, which remains the world's biggest producer of millets. As dryland crops, they are often grown as part of a risk mitigation strategy (Annex Figure A1 for rainfall requirements of some millets compared to other crops). Despite their long history and suitability for certain growing conditions, area under millet production and per-capita millet consumption has been declining in India — Annex Figure A2, with both roughly halving from the early 1960s to recent years. Small millets in Tamil Nadu State, the heart of this project, declined strongly in area and production from the early 1960s. However there is some indication of a comeback for at least a few varieties in recent years — see Figure 1 — with finger millet production in 2014/15 even exceeding its levels six decades before, in spite of a much smaller planted area (more detail and comparison to other coarse grains in Annex Box A1).

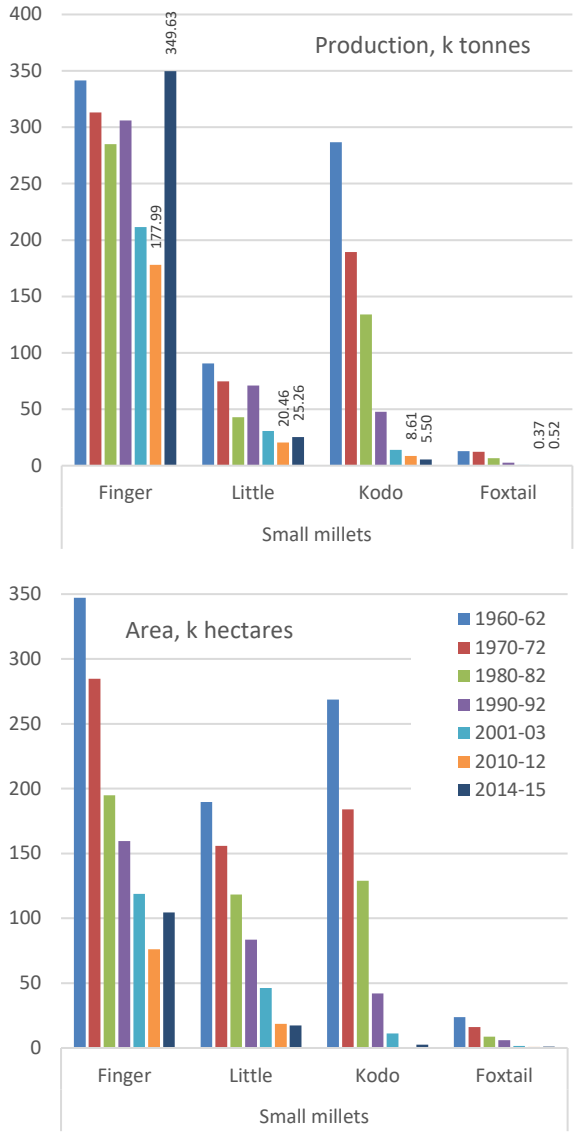
The key food security challenges identified by project implementers are at least threefold (Karthikeyan, 2017):

4. Triple burden of malnutrition — characterised by stagnating undernutrition in under-fives, widespread micronutrient deficiencies, and rising overweight and obesity
5. An increasing burden of non-communicable diseases (NCDs), including diabetes, cardiovascular and intestinal disorders, cancer
6. A decline in diversity of diets

Small millets are offered as part solutions to these challenges. Firstly, they are more nutritious than the far more commonly consumed rice or wheat (See Annex Figure A3 for nutrition profiles of millet compared to maize, rice, wheat, and sorghum). Secondly, they have medicinal properties: chiefly a low glycaemic index that keeps people feeling fuller for longer, and thus has preventive or curative properties for illnesses associated with blood sugar.

The small-scale dehulling being promoted removes less bran and nutrient-containing seed-coat than large-scale processing and polishing – see Box 1 for more detail.

Figure 1: Trends in small millet production and area, Tamil Nadu: 1960-62 to 2014-15



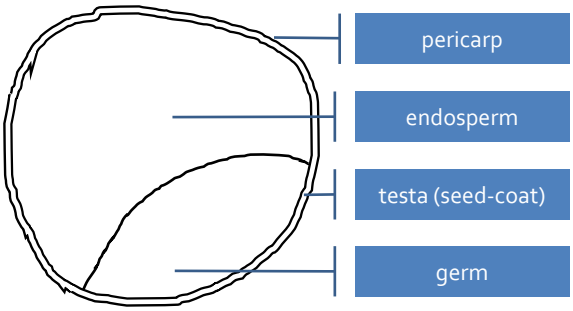
Source: Compiled by J. Jeyaranjan from Season and Crop Reports, Department of Statistics, Government of Tamil Nadu.

Box 1 Processing small millet for consumption.

Small millet varieties, as with major millets like sorghum, consist of an outer layer (the pericarp), a thin layer underneath the pericarp (called the testa, or seed-coat), and the kernel comprised of endosperm and germ – See Figure 1.1. In SM the pericarp is like a sack, only loosely attached to the endosperm at one point; whereas in sorghum and pearl millet the pericarp is completely fused to the endosperm.

With much of the nutrients contained in the layer outside the endosperm, when dehulled grain, called 'millet rice' is highly polished, it tends to be white in colour. This is less nutritious than millet rice which has been dehulled but not so polished, retaining some of the outer colour.

Figure 1.1: Anatomy of small millet



Sources: FAO, 1995; fieldwork

They are further championed for their environmental credentials. In terms of their characteristics as crops, they form part of biodiverse systems, often grown intercropped with pulses like horsegram or field bean, as well as uncultivated edible greens rich in micronutrients. On top of this, they are drought resilient crops, traditionally grown in dry conditions.

While the project's immediate focus is on improving availability and access to micronutrient-rich food in the form of SM, it is part of a broader attempt to preserve old traditions, crop biodiversity, and to bring more environmentally friendly methods of production to the fore. Given the lack of political support for millet and its decline over the past several decades, another element of the project seeks to broaden the political discourse around food security to include SM. This is done through for instance efforts to establish SM in school meal schemes, as well as the public distribution system (PDS), which has for decades focused on boosting poor people's availability to a limited bundle of staples including rice, wheat, and sugar.[3]

Nagarajan et al. (2006) summarised some of the policy neglect

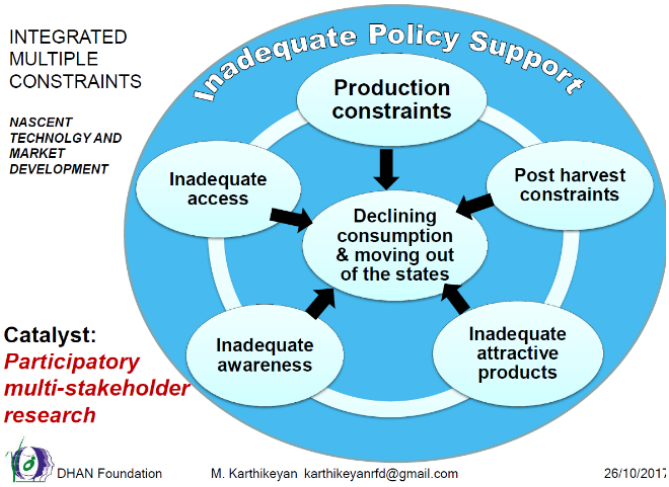
> "Notwithstanding efforts made at the national level to collect germplasm material for the minor millets, the research intended to improve this crop is negligible. Moreover, the national area and production statistics for minor millets are also poorly compiled, grouping minor millets among coarse cereals for reporting purposes. ICRISAT and International Plant Genetic Resources Institute (IPGRI) along with national and non-governmental organisations have made efforts to document the diversity among these crops and have

[3] The PDS system arose at a time when calorific availability and access were the prevailing food security concerns. This understanding is increasingly outdated as India undergoes the nutrition transition.

included finger millet in its research mandate from 1998. Still, other minor millet crops have received little attention in the research mandate of national as well as international research institutions."

Millet is by no means an 'easy' solution to the challenges identified. Multiple constraints, exacerbated by inadequate policy support conspire to hold it back (Figure 2): against these the project also battles. Examples of these constraints include — in production, access to good seeds, land, labour and other timely inputs; in post-harvest, processing and storage; in inadequate attractive products, insufficient availability of millet-based foodstuffs that are appealing to consumers; in inadequate awareness; people's lack of understanding about the benefits of consuming SM; and in inadequate access, the inability of people on low incomes to afford many small millet-containing foodstuffs, including lack of SM in PDS or school meals programmes.

Figure 2: Constraints facing small millets



Source: Karthikeyan, 2017

1.3 Methods

This case study is largely informed by two weeks of fieldwork by London-based ODI staff and an independent consultant at the Institute for Development Alternatives, based in Chennai; facilitated by DHAN Madurai and their implementing partners in Tamil Nadu (see some snapshots from the field in Annex B). Fieldwork has been supplemented by existing studies and reports linked to the project, including those generated by the project, as well as interviews with DHAN, TNAU, and McGill University staff.

Fieldwork was the most resource-effective way to quickly come up to speed on the case study projects, while collecting qualitative testimonials from beneficiaries of the projects, practitioners, and other stakeholders in the field, centred in Tamil Nadu State, as this was the hub of DHAN and TNAU operations on SUSM.

To understand the project, we consulted a comprehensive range of key stakeholders while in the country. Key stakeholders interviewed included members of farmer producer organisations, millet farmers, millet food producers with micro, small, and medium enterprises, machine manufacturers with small and medium scale enterprises, a women's federation leader, women's federation members, DHAN staff, and TNAU staff. A full list and count of stakeholders interviewed are available in Annex Table A1, while Annex Tables A2 and A3 detail features of each of the three machine products manufacturers and 12 value-added food producers visited.

Theories of Change (ToC) were constructed for key actors and beneficiaries, following John Mayne's ToC COM-B models, which track how Capacity, Opportunity, and Motivation lead to Behaviour change (see for instance Mayne, 2016) (more on this in the Review of Project section).

Questions posed to stakeholders were developed around these ToCs, to do with their participation in project activities, changes to their capacity, their opportunities, and their motivation, leading to changes in their behaviour and subsequent results or implications for food security.

Given the resources available, the ODI/IDA Chennai team tried to sample a range of project experiences, relying on steers from the implementing organisations. Selection of experiences was thus not random, but random selection would have reduced time in the field and hence the breadth of experiences reviewed.

The timing of the study means this report was initially prepared in December 2017, around six months shy of the project's completion scheduled until end of May, 2018. Although many of the intended activities had been rolled out, implementation was ongoing, making it difficult to test some results. For instance, the likelihood of people's behaviours continuing beyond the end of the project (for sustainability) was difficult to gauge.

1.4 Rest of report

A review of the project follows, including a brief description of a series of nested theories of change (ToC) for its main actors. Results and preliminary implications follow, while the final section provides a preliminary assessment, with reference to sustainability,

scaling up, CIFSRF's contribution, gender, and other reflections.

2. Review of project

2.1 Project logic

How was the SUSM project designed to address the food security problems diagnosed? Nested Theories of Change, constructed for the main beneficiaries of the project, structured around a COM-B narrative — whereby interventions of the project influence beneficiaries' capacities, opportunities, and motivation (COM), leading to Behaviour change (B) — can be used to illustrate the project logic. Parallel to these processes, theories of change also record flanking narratives which contribute to the functioning of the project — with factors on a spectrum from those over which the project has no control, to things firmly within its sphere of influence.

Four ToCs are presented to separate out main actors and beneficiaries, a necessary complication given the complexity of this project. Figure 3 provides an overall logic. The programme is loose-coupled, so that actions that are not necessarily closely linked work towards a general goal.

Though this phase of work concentrates on the machine manufacturers and millet value-added food producers, while work with farmers is minimal, theories of change are included for farmers as well, given their centrality to the project motivation.

Figure 3 Project logic of Scaling Up Small Millets

Activity	Capacity & Behaviour change	Results	Impact
Technical assistance to machinery manufacturers	Machinery manufacturers make suitable millet dehullers	Dehullers sold: profitable business, jobs	See below
Assist farmer organisations to access dehullers	Farmers use dehullers, choose to grow more millet, eat more millet	Profits to farmers, time saved, reduced drudgery, preserving traditional cropping systems	Healthier people and environment
Technical assistance to millet foodstuff producers	Millet processed-food producers[4] use (more) millet in more products, with improved hygiene standards	Generates profit, in some cases jobs	Healthier consumers
Encouraging millet consumption	Consumers eat more millet	Gives a boost to demand for millet, improves people's health	Healthier people and environment

Source: Authors construction.

2.1.1. Equipment manufacturers' theory of change

Table 2 sets out the theory of change for equipment manufacturers in this project, while subsequent Tables 3, 4, and 5 show the ToCs developed for millet food producers, millet farmers, and millet consumers respectively. The ToCs are constructed from the bottom-up with the central column holding the intervention narrative; so that ***Activities*** in the end row, lead to ***Capacity changes***, which in turn drive ***Behaviour changes*** and yield ***Results*** and ***Impacts*** captured in the top two rows. The left-hand column records the enabling narrative — where actions or activities by others (not necessarily associated with the project) helped contribute to it; while the right-hand column records assumptions — things largely beyond the control of the project. Horizontal linkages also exist between the ToCs (for instance, as outputs of equipment manufacturers feed into ToCs for women millet farmers); these are depicted in red text.

[4] At Micro, small, medium, and large scales. Micro enterprises are those which are very small subsistence businesses, as in the millet porridge street-side vendors. Small and medium businesses are those with household level or small to medium scale processing units catering to largely local or sometimes regional markets. Large enterprises include large millers and snack producers who produce large volumes reaching national markets

Table 2 Theory of change for equipment manufacturers

Enabling narrative. Activities by agents within the programme's influence	Intervention narrative	Assumptions about elements beyond the programme's control or influence
	Impacts Improved welfare for equipment manufacturers, their employees and associated families [Knock on impacts for millet farmers who access the machines – Table 4]	
Farmers/FPOs, other users of the equipment (standalone processors) are aware of its availability, see a good/growing market for millets and seek to invest [linked to Table 4]	**Results** Incomes for companies generating work for (more) employees [Link to Table 3] — labour saved by farmers /farm groups/processors using the equipment instead of processing by hand (usually women) Farmers are motivated by presence of equipment to plant (more) millet	
Companies have existing skills and capabilities to do with machine manufacturing New government schemes around SM are generating demand for dehullers. Groundwork on equipment manufacturing, improvements to old versions. Millet advocacy by various groups means equipment manufacturers see a viable market.	**Behaviour changes** Companies manufacture dehullers and sell them Farmers/FPOs, use equipment **Capacity changes** C: Companies able to produce and sell equipment O: Market demand for equipment M: Profit **Reach**: On dehuller supply: work with 5 machine manufacturers.	Fills a gap in the market. Markets can accommodate sales of equipment without prices falling unduly (while equipment is affordable to target population at the same time)
Earlier CIFSRF projects developed and tested appropriate scale SM processing equipment.	**Activities** Business development support offered to existing and new equipment manufacturers Technology transfer Information about market potential. Support with demonstrating / advertising dehulling equipment	

2.1.2. Millet food producers' theory of change

Table 3: Theory of change for millet food (snacks/meals) producers

Enabling narrative. Activities by agents within the programme's influence	Intervention narrative	Assumptions about elements beyond the programme's control or influence
	Impacts Improved standard of living for snack suppliers and their families / employees Healthier consumers [Table 5]	
New millet products are healthy: without undue use of oil, sugar, salt (Partially influenced by TNAU training, DHAN distributed recipes)	**Results** Improved incomes / profits for snack suppliers and where applicable, employees Improved availability of millet-based foods Healthier consumers given products are more hygienically and safely produced [Also see Table 5] Feeds stable, sustainable demand for raw millet as an input, helping farmers [Table 3]	That market factors, such as any sudden glut of product from elsewhere, or any sudden drop in demand will not add undue volatility to prices
People are familiar with preparation of millet — through this or other millet promoting initiatives Earlier CIFSRF projects have developed appealing SM food products. (40 kinds) boosting profile and appeal of SM among rural and urban consumers. India is the world's top producer of millet, which has become a key target crop for the government: In 2014, the government of India included millet (among a range of "coarse" food grains) as part of its national food security strategy to promote their cultivation/use, especially in marginal areas.	**Behaviour changes** New Micro and SME food producers make and sell millet-based foods Existing Micro and SME food producers sell more millet-containing products, with better hygiene/food safety practices Public food organisations include millet on the menu differently / more than before Consumers eat more millet-containing products [Table 4]	Rising demand for millet exists (Millet is re-emerging as a health food for the middle and upper-class). [Demand also rising among the poor, in part influenced by awareness-raising by this project, Table 4] Millet is regularly available in expected places, at expected times for expected cost. Local markets can accommodate more sales without prices falling unduly

	People will stop viewing millet as 'grain for the poor'
Capacity changes C: Private (and in some cases public/NGO) enterprises of various sizes (new or existing) are able to prepare and sell (more) healthy, safe, millet-based foodstuffs O: Consumer demand exists for millet snacks M: Improve incomes **Reach**: New and existing SMEs, microenterprises, FPOs. In predominantly Tamil Nadu, but also Andhra Pradesh, Odisha, Chhattisgarh Public/NGO sector food distribution — e.g. midday meals of Akshaya Patra Foundation Plans to increase consumption of SM food products by more than 150k consumers in India via: 1) Interested individuals, mainly women providing for their family, 2) Micro enterprises, including street vendors, 3) SMEs, including hotels/food services, 4) large-scale food industry such as Britannia, 5) Farmer Producer Organisations (FPOs) and 6) Public food programs. More detail: Business incubation support to 10 SMEs and customised training and support to 150 micro enterprises and 3 FPOs. Each micro enterprise is expected to serve 500 consumers and each SME and FPO is expected to reach 3000 consumers. Also aims to develop links with public food programs and large industries to reach an additional 10k consumers.	

Link to ToC for Equipment manufacturers [Table 1] — Dehulling machine is made available for SMEs processing millet into foodstuffs.

Builds on lessons from two previous CIFSRF Phase 1 projects: Enhancing food security of rural families through production, processing and value-addition of regional staple food grains in India & Revalorising minor millets in rain-fed regions of South Asia.

A key lesson from both: need to actively engage the private sector to ensure sustained buy-in and uptake.

Project aims to learn from current initiatives distributing SM foodstuffs in public channels.

Activities

Customised business development support to existing and new SMEs, micro enterprises (e.g. street vendors of porridge), and farmer organisations. Involves support from Kalanjiam Thozhilagam Limited (private arm of DHAN, offering business support)

- Building capacity around food safety procedures/ meeting food safety regulations.
- Providing enterprises with market information on SM foodstuffs — e.g. trends in consumption, consumer acceptance, comms strategies, scientific data for branding (e.g. health benefits).

Project assumes the current policy support for millet will continue

2.1.3. Millet farmers theory of change

Table 4: Theory of change for millet farmers/processors, especially women

Enabling narrative. Activities by agents within the programme's influence	Intervention narrative	Assumptions about elements beyond the programme's control or influence
	Impacts Improved incomes for farmers/processors with positive implications for food access/security Farmers eat more diverse diets and become healthier / preserve good health	
That good transport services exist to get products and sellers to market, as well as to allow consumers easy access	**Results** Time saved on processing, especially by women, reduces drudgery and leaves them free to do other things (knock on benefits to families' nutrition) Farmers feel encouraged to produce more millet given it is now easier to process. Wider availability of millet [link to Tables 2 & 4] Sale of processed millet (including avoiding sales during price slumps at harvest time) may achieve better prices for farmers Preservation of a traditional low-input, diverse cropping system.	That women don't use the time saved to do other excessively laborious tasks. Farmers planting decisions are influenced by the post-harvest processing available
Other NGOs, government etc active in promoting millet production and foodstuffs	**Behaviour changes** Farmers / processors obtain (purchase or are given through for example state programmes) dehullers and use them	Dehulling machines are used by women; men do not co-opt millet processing as it has become easier. Dehullers are accessible to potential users
Using machines as opposed to other methods is cost effective — machines shown in earlier research to save significant time, and unit costs have been brought down. Easy to maintain and if they break down they are readily fixed with local capacity	**Capacity changes** C: Women able to process millet in less time, to higher quality standard O: Achieve better prices for millet, save time, reduce drudgery M: Improve incomes **Reach**: By May 2017; equipment supplied by manufacturers to 42 new community processing units, 29 micro-processing units in 29 districts in 8 states. 7 community level processing units were revived or improved. Three FPOs had started procuring and processing SM, and selling SM rice to member based organisations of women/ farmers, reaching 11,500 families.	That farmers are choosing to plant millet
Equipment manufacturers ToC [Table 1] means low-cost machines can be used by farming communities.	**Activities** Dehullers are made available to farmers, farm groups, existing processors who are using inferior technologies	

2.1.4 Millet consumers theory of change

Table 5: Theory of change for millet consumers

Enabling narrative. Activities by agents within the programme's influence	Intervention narrative	Assumptions about elements beyond the programme's control or influence
	Impact Healthier consumers with more diverse diets	
Transport services exist to get products and sellers to market; to allow consumers easy access	**Results** Nutritional gains for consumers and their families, including adolescent girls and pregnant women[5] Stable markets for producers helps them maintain stable income [links to Table 2]	More limiting factors behind malnutrition are addressed concurrently — e.g. better health, feeding practices, improvements to women's status for instance helping to drive falling rates of anaemia and stunting. [If the programme is successful, it will be contributing; may not be the chief driver] Nutritional deficiencies are not genetic and can be corrected with diet. Other foodstuffs rising in popularity e.g. quinoa will not displace millet.
	Behaviour changes Consumers access and choose to eat more millet	
Other NGOs, government etc active in promoting millet production and foodstuffs	**Capacity changes** C: Consumers understand health benefits of eating millet. C: Consumers have ready access to SM containing foods O: Desire to improve diets/health. O: Millet cheap / freely available in school meals / PDS M: Healthier selves and families; cost, taste **Reach**: All the consumers of foodstuffs produced by those covered in Table 2; Farmers in [Table 3] who eat (more of) their own production; Consumers reached through DHAN Women's Federation(s). Those accessing millet through PDS / school meals	
Previous work from RESMISA on promoting millet at the farm level helps with raising people's awareness. Activities publicising millet foodstuff producers products [Table 2] and millet dehullers [Table 1] also help raise awareness of SM.	**Activities** Project works to improve awareness of small millets and their benefits. A key avenue is via DHAN's women's federation in Salem. • Demonstration of value-added products and recipes; advocating for millets as part of nutrition education e.g through pamphlets, walkathons around SM, in schools	

[5] Millet being higher in micronutrients like vitamin B complex, calcium, iron and sulphur, also high in dietary fibre and low glycemic index

McGill / TNAU technical work on therapeutic or health properties of SM feeds into the outreach activities.

Existing work on health properties of millets by other actors

- Distributing small millets to federation members and adolescent girls
- Making small millets available at federation shop
- Incorporating SM in training to pregnant women through federation work in health clinics
- Training of trainers (clinic staff) on small millets

Project seeks to introduce small millets into public food programs — e.g. school meals and PDS.

Media and outreach on SM through e.g. Making motivational songs on health benefits and other virtues of small millets; radio programmes on SM, campaigns in production areas to motivate consumption there; value-added demonstrations, SM recipe films, murals.

Project work on getting SM into foodstuffs through micro and SMEs [Table 2]

2.2. Testing the theories of change

2.2.1 Equipment manufacturers

The project has been working with five equipment manufacturers — two in Salem, three in Coimbatore, to transfer technology, improve the machines on offer, and to increase their sales. All are experienced manufacturers of agricultural machinery — the project having been careful to select successful operations to work with to ensure quality and sustainability.

Activities

The three equipment manufacturers visited in the field — two in Salem, one in Coimbatore (see Annex Table A3 for a brief profile of each), all maintained they had been helped by DHAN and TNAU. Activities included: marketing and sales — for example, making links to buyers through subsidised stalls at events, participation in trade fairs, advertising, and enrolment in online sales. In the case of AVM Engineering, DHAN helped the company win a contract to supply 35 machines to an Andhra Pradesh state scheme. Other notable activities included improvements to machines or help with R&D, through assessments of existing machines by expert panels who suggested ways to improve upon them, as well as though providing some manufacturers with the opportunity to learn from more compact machines. The machine engineer at Victor Agro-Sales for example has plans to produce a small household level machine, modelled on a small and highly efficient rice dehuller DHAN purchased from Japan and brought for him to examine.

Capacity and behaviour change

Capability changes are bringing behaviour change, with manufacturers producing and selling improved millet dehullers[6] — often as part of more integrated machines that perform other tasks such as destoning and grading.

Over the last five years or so, AVM technologies has moved exclusively into millet machines. Following their involvement with DHAN, they have sold maybe 50 large units — before they produced only single-chamber dehullers. Victor Agro-Sales gets about 20% of their business from millet machines, with sales growing. Five years ago, they were selling perhaps one dehuller month; now they sell as much as 20 a year. Perfura technologies, the newest of the businesses ascribes about half their work to millet machines. In 2017 they sold around ten millet double stage dehullers, and had won orders to provide machines to 12 hubs under a project funded by the Tamil Nadu government.

Moreover, machinery is continually being improved upon, with some of the manufacturers heavily engaged in machine R&D.

A rising market demand exists for the millet dehullers, with manufacturers all reporting improvements in sales in the last few years. In the last reporting period (Dec 16th 2016 to June 15th 2017), some 81 processing machines were sold by four of the five equipment

[6] Some improvements on the original prototypes already made include: fitting separate motors for aspirators and hullers to replace a single motor version, increasing flexibility; reducing the space between the guard and moving parts to increase safety (for instance reducing the likelihood of saris becoming caught up); adding an emergency stop button. (Karthikeyan and Raghavan, 2017)

manufacturers, reaching 15 districts in seven states across India (Karthikeyan and Raghavan, 2017). Compared to the previous reporting period, millet dehuller sales from AVM Engineering grew more than 200%, while those from Victor Agro-Sales improved by over 100% (ibid).

DHAN's analysis of market potential undertaken in four provinces with significant area under SM cultivation[7] estimated a market of perhaps 1,400 village-level machines, 200 for micro-processing enterprises, and 20 for medium scale processing enterprises (Karthikeyan and Raghavan, 2017b).

Results

Given significant growth of their businesses, incomes have improved for the machine manufacturers. Victor Agro-Sales, in Salem, for instance, now sells some 15 to 20 dehullers a year, while five years ago they were selling perhaps 12 dehullers a year. Profits per machine have not changed much, though some costs have increased. Notably, these small businesses have been hit by changes in GST, though they have been able to absorb the extra costs without undue difficulty. Costs of labour have also increased significantly in the last five years; an India-wide trend reflective of tightening labour markets as India progresses through the demographic transition and develops economically. Salaries of staff have risen significantly. In Perfura Technologies for example, staff who started a few years ago on an average salary of around 350 rupees now earn up to 700 per day (about CAD7 to CAD14). Some hope these improved wages will enable them to relocate families from distant states.

Other benefits flow from improvements to machinery — smaller machines are easier for men and women to operate; those with better guards are less likely to catch up saris or other loose clothing, while an emergency stop button has clear health and safety implications.

2.2.2. Millet foodstuff producers

Activities

The DHAN/ TNAU team have offered training and support to a large number of micro- and small enterprises involved in making millet foodstuffs. Ninety-two millet pushcart porridge vendors in Madurai and Krishnagiri for instance are being supported in various aspects including to follow better food hygiene and safety practices, to diversify millet snack items on offer, and to apply for certification from the Food Safety and Standards Authority of India (FSSAI). Several small and medium scale enterprises, such as those producing millet food mixes or millet biscuits are also being helped; not only in Tamil Nadu — training has also been provided in Odisha and Andhra Pradesh (Karthikeyan and Raghavan, 2017).

The food enterprises of various sizes visited in the field — six in or around Madurai, five in or around Coimbatore, and one in Tiruchirappalli, had all received assistance from DHAN and/or TNAU (see Annex Table A4 for a brief profile of each). They have attended trainings and had help on techniques ranging from food safety and security to millet recipes and production techniques, to business development, book-keeping, and marketing.

Food producers have been given cash grants, physical supplies or loans from DHAN — for instance to develop their packaging, to have their products nutritionally analysed by TNAU, to purchase sanitary storage tubs, to purchase machines like batch coders or pulverisers, and to attend and exhibit at trade fairs where they might make valuable contacts. DHAN had arranged for almost all of the small enterprises visited to exhibit their foods at fairs, where they have gained more contacts and widened their markets.

Capacity and behaviour change

Micro and SMEs have learnt to improve their food health and safety. They have improved business management (some of the small enterprises mentioned improved book and record-keeping, following support from DHAN, was allowing them to better run their businesses and to gauge supply and demand). Marketing skills have also been boosted — through for instance packaging that has been modernised so it can be marketed in more retail settings: this might entail simple changes like switching packaging from floppy plastic bags to rigid bags that can stand on shelves; or by including batch codes that are required by supermarkets, as well as labels that include nutritional content or more appealing designs.

The project has enabled these small enterprises, most of which are driven by women or by married couples, to achieve more than they were able to before.

Some of the healthier practices stand out: street porridge vendors, for example, are running more hygienic operations — porridge is served with a ladle rather than scooped by hand, drinking water is served in a closed drum with a tap rather than from an open drum

[7] Odisha, Andhra Pradesh, Madhya Pradesh, and Uttarakhand

system, side dishes are covered and no longer affected by dirt from moving traffic, immediate surroundings are kept swept and free of garbage — all factors contributing to improved food safety. Small enterprises too are storing food more hygienically — in storage drums, or behind mesh to exclude rats and pigeons. Microbial testing by TNAU has identified a few cases of contaminated foodstuffs, whose producers have been urged to improve.

Results

Of the 58 micro enterprises offered customised training in in Odisha and Andhra Pradesh, eight have already started selling SM food products, while two canteens have introduced SM into their menus (Karthikeyan and Raghavan, 2017). Overall, micro and SMEs are producing more products, safer products, higher quality products, better branded products, products with nutritional content information, products that can be marketed to a wider customer base. Changes occasioned by the project have led to improved sales and incomes. Some examples:

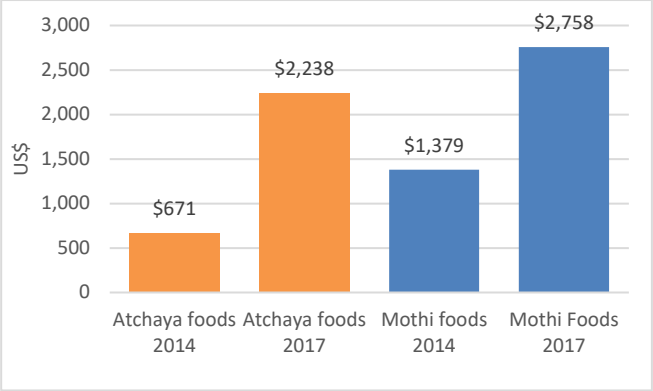
Green Happy Foods, a micro business in millet biscuits, a complementary business run alongside the family's main business of running a print shop – reports business has grown 3 times in 3 years.

Padma Sree Foods – a small home-based enterprise run by a woman in Madurai, began 5 years ago. She now sells around 15,000 rupees worth a month, making about 50% profit, which after paying distributors brings her around a 30% profit.

Atchaya foods for example, run by a wife and husband team in Madurai reports they are now selling about 100,000 rupees' worth of millet-containing foodstuffs a month; three years ago, sales were around 30,000 a month. They make about 20% profit on this turnover, though a large share (some 10 to 15%) goes as commission to sellers.

Mothi Foods have monthly sales now of around 60,000 to 70,000 rupees, with profits of around 15,000 rupees. Turnover three years ago was about half that. These last two examples are shown in Figure 4.

Figure 4: Estimated annual household income from millet product sales for two small businesses – 2014 and 2017



While it is has not been possible to test the extent to which an individual change such as including nutritional content in packaging might improve marketing, the potential to attract more customers is clear.

In the case of 11 of the 12 food producers visited, parts of the businesses associated with SM had improved and grown over the last few years — both in terms of more small millet-containing products, and in terms of volumes sold. The exception was an instant noodle producer (Artifood products) put out of business by GST changes. Though he was running a relatively small operation, very similar in most aspects to a nearby one, the use of a particular type of machine to extrude the noodles meant the business attracted 18.5% GST rather than 5%; a hike in costs that could not be absorbed given the businesses tight profit margins and competition with multinationals.

For several producers, costs had increased, including for instance labour costs, but concurrent rising of sale prices or scale up of sales were bringing better profits.

Impacts

Following the causal chain, livelihoods of those running micro enterprises, their employees and associated families improve with growth and success of their businesses. For micro enterprises like porridge vendors, millet sales are their only, subsistence business, so any improvement in profits have a significant benefit for the operators[8].

Health benefits from eating more hygienic food, while not simple to observe, logically flow from the causal chain. If for example street porridge vendors or small enterprises are producing and storing food in safer conditions, consumers will benefit from this safer food.

[8] For some of the other small enterprises, the businesses are part of family diversification strategies, whereby some of the partners running the businesses also had jobs elsewhere (for instance in teaching, or in owning other shops), so improvements have a more marginal influence on family finances and consequent welfare.

2.2.3. Farmers

While this phase of the CIFSRF project focuses its energies upstream from millet farmers, some farmers were visited to determine the extent to which the presence of millet dehullers might be occasioning changes in their behaviour. This was of interest because reducing women's drudgery in dehulling was a key motivator for selecting SM dehullers for scale up in this phase

The sample of farmers visited in the field was unfortunately quite small. Only two groups of farmers — some in the Periayur FPO, and some near Sengapadai were interviewed. Those near Sengapadai were a bit far from the dehuller to be using it regularly — they thus may not be entirely representative of famers' experience with the small machines.

Discussions with farmers made clear; not all of the ToC's assumptions about SM have held up. Millet does not seem, as it once was, a food for the poor against which people are particularly prejudiced[9]. Among the poor, it is no longer regularly eaten. Of the farmers interviewed, only one, an old man, ate millet regularly. For the others it was far more common to eat rice. Indeed, rice is so readily available, thanks in part to public distribution policies[10], that it has been a long time since millet was the food of choice for the poor. Increasingly it is a health food for middle- and upper-class urbanites.

Activities

By May 2017, equipment manufacturers working with the project had supplied dehullers to 42 new community processing units, 29 micro-processing units in 29 districts in eight states. On top of this, seven community level processing units were revived or improved. Three FPOs had started procuring and processing SM, and selling SM rice to member based organisations of women/ farmers, reaching 11,500 families.

Capacity and behaviour changes

Reports from farmers met in the course of the fieldwork were mixed. While some of those interviewed, particularly in the Periayur FPO, suggested they were using the millet dehuller to process small batches of millet for their home consumption, many of the women farmers interviewed near Sengapadai said they were still dehulling millet by hand. While it was time consuming, they felt it made sense to process the millet in smaller amounts given it would quickly deteriorate in quality after processing[11]. The distance to the dehuller was too far to travel[12] for only processing small amounts, while processing large amounts was impractical given the shelf life. With more small-scale dehullers closer to home (something this project aims to achieve), these concerns could be overcome. Processed millet keeps for a shorter time than other grains, so most households process it in smaller quantities more frequently. Several of the farmers we spoke to indicated they sold the majority of their millet from the threshing floor to be processed in bulk elsewhere. For others, presents of dehullers in farmer federations and milling stations gave farmers access to an easy way of milling their grain, and may have resulted in them retaining more for home consumption, rather than selling the bulk immediately as is the habit.

Some millet was however stocked in the Periayur FPO, waiting for an order before it might be dehulled and shipped[13]. Records at the mill suggest it was processing around 100 to 200kg of SM each month.

Some farmers interviewed also felt the quality of hand-dehulled millet was preferable. It may for example contain fewer broken grains than that which has been through the mechanical dehuller a few times. Preliminary findings from an evaluation the village-level hulling equipment by project implementers found that some machines visited were not functioning — owing to factors including machine quality, milling agency decisions, and lack of support systems. For those that were functioning, two critical needs were identified: firstly — to improve the quality of dehulled produce (for instance, in reducing broken grains); and secondly, to promote the existence of processing units in order to motivate farmers to use them more often and increase their consumption of SM (Karthikeyan and Raghavan, 2017).

[9] Being a dryland crop it was once associated with poorer farmers who could not access rivers for irrigation. Historically, rice was considered a more desirable crop, given it could be produced in by wealthier famers in irrigated schemes.

[10] PDS in Tamil Nadu is universal and supplies rice for free – 20kg/month per family. For the poorest of the poor, there is a special scheme known as Antyodaya Anna Yojana (AAY) which provides 35kg /month freely.

[11] Millet rice only keeps about two months, while the whole grain keeps 3 years or longer.

[12] DHAN is working with machine producers on a much smaller and very energy efficient dehulling prototype that might be easily transported or even used at a household level (modelled on a rice dehuller they imported from Japan)

[13] Buyers tend to be millers; snack producers are buying their millet from wholesalers rather than sourcing it directly from FPOs owing to the smaller amounts required.

Results

Women's drudgery

Preliminary findings from the project implementers' evaluation of the impact of village-level hulling equipment on their largely female users suggests women did identify the reduction in drudgery and time taken for processing as the main benefit of using the SM processing units. The extent of the benefits however varied by user, machine, and site (Karthikeyan and Raghavan, 2017).

Farmers planting decisions

While it is has not been possible to evaluate whether or not this CIFSRF phase is influencing farmers to plant more SM, travelling to and from the field sites, it was apparent that DHAN has introduced millet varieties from other locations in some places to improve the productivity of the crop, and have succeeded in that experiment. We passed a large field of one variety of barnyard millet (from Karnataka) not normally grown in Tamil Nadu that had been introduced in the first phase.

Presence of dehullers may be leading some farm families to produce (and perhaps consume) more millet, though this seemed to be the case of maybe only a quarter of those interviewed.

How significant is the presence of a dehulling machine for those growing SM? While we might have assumed in the ToC that dehullers would influence planting decisions, given farmers who know they are able to sell processed millet for a better price through the FPOs with dehullers might be inclined to plant more millet, it was not clear from our interviews with farmers that the presence of a dehuller was encouraging them to plant more. Planting decisions are affected by so many variables — see some reflections in Box 2. It is difficult to draw conclusions however from our relatively small sample size.

Box 2 How do small millets feature in farmers planting decisions?

For most of the farmers interviewed, SM were a relatively minor crop. Finger millet, which seems have be seeing a revival (Figure 1) is perhaps an exception. This SM variety has received more attention from crop science programmes than other varieties. Its price has also been rising; for many years it was very low — achieving a maximum of 10 rupees/kg: now it sells for up to 30 rupees/kg.

When it comes time to make planting decisions, SM compete with a host of other, potentially more lucrative crops. Sorghum for instance has been grown more and more in recent years, fetching very good prices. Because cotton achieved high prices in 2016, in 2017 many farmers chose to grow cotton. Millets are grown often as a last choice.

The decisions are also influenced by available labour (SM may achieve less than maize in good years, but require fewer labour inputs), and perceptions of how well SM will fare — some marginal land may be only suitable for millets, though in 2016 even SM failed widely, owing to an extreme back to back drought (not seen in the state for 150 years), though some might have still been harvested for fodder. At the time of the fieldwork, 2017 was shaping up to be a good year.

Local seed availability has also been identified as a key factor in planting decisions, with farmer varieties (farm-saved seed) prominent in the case of SM (Nagarajan et al., 2006).

Moreover, tastes and preferences influence planting decisions; millet is not a staple food among the young, and only the elderly report eating it regularly.

Farm families' diets

Several women said their millet harvests are sold to the commission agents from the threshing floor, with small amounts purchased back for household consumption in the form of millet rice. Millet consumption even among the poor and working-class group was reported to be meagre. Some of the younger farmers did however mention that health concerns among family members — for instance diabetic parents — were influencing them to eat more millet. DHAN staff report some 70% to 80% of the millet grown in the regions where they have been working over the last 7 or 8 years is not consumed by the communities.

Traditional low-input diverse cropping systems preserved

Ecological benefits of growing SM also exist: as discussed, SM form part of dryland cropping systems with low-input requirements; and as such they are relatively environmentally friendly. The traditional way of raising SM requires occasional use of urea (manure being less available with mechanisation and declining numbers of cattle), and few other inputs (pesticides for instance are not necessary). Small millets are key to biodiverse cropping systems, often intercropped with pulses or oilseeds, and in sites of uncultivated micronutrient-rich greens.

Impacts

Incomes

Those farming SM who have been able to sell processed millet through FPOs are achieving a better margin on their crops (as well as the better prices achieved for millet rice, they can sell later and avoid the price troughs around harvest time). Whether the presence of small-scale dehulling machines is influencing planting decisions or not, state-wide statistics have captured a

dramatic upswing in finger millet[14] production (to 2014/15). It will be interesting to see if potential increases starting to show in other varieties (Little and Foxtail) are also sustained, though it may not be possible to determine the contribution of this project to any increases seen.

Small millets, often grown as a risk mitigation crop that will survive even if major millet fails, may improve farmer incomes, particularly in years of poor rainfall. In 2016 for instance during the 150-year drought, some SM leafy fodder was still sold for high prices — fetching more than the grain.

How significant are the income boots to farmers of SM? For most of those millet farmers interviewed, main sources of household income (hence drivers improving food access) were off-farm — see Box 3.

Box 3 Off-farm sources of income large and rising

Most men in agricultural communities now go outside for work — some migratory and some daily. They are employed in many areas, including construction and brickmaking. Married women too engage in off-farm work so that in many cases grandparents are left to care for children.

In the hamlets visited, the older generation were more involved in agriculture compared to young people. People said that agriculture had become a secondary kind of occupation. Time may be divided so that in the early morning, people tend farms before leaving the village for outside work. During planting times, they may stay longer in the village.

Many families only engage in agriculture they can sustain with family labour. Opportunities to earn much more exist outside agriculture, so labour is expensive. The average holding size is so small that most can manage with family labour. Few hire extra help as it is often not worth the extra cost. During harvest time, when around 10 workers are required per acre to harvest, most is done using labour exchange because wage rates are very stiff.

Rural non-farm employment has been steadily increasing in India and particularly in Tamil Nadu in recent times. In the process, agricultural incomes of rural households have been relegated to secondary status. Apart from the small size of the holdings, the vagaries of monsoon, highly volatile prices in the market, shrinking margins, escalating labour and other input costs act together to fuel the diversification of occupations of Tamil Nadu rural households. The spread-out pattern of urbanisation and the highly developed transport network (bus services are very good even in small villages connecting maybe four times a day), enables this process of diversification.

While it has not been possible to necessarily observe changes in the health of producers during the fieldwork, it is reasonable to expect they exist. Big changes in the health and nutrition of, particularly rural people has likely come in the last ten years or so from parallel processes, including better provision from health centres, improved (piped) water services, and improved hygiene and sanitation available.

2.2.4. Millet consumers

Activities

One major strand of this CIFSRF phase two project has been on awareness-raising and positive publicity around SM. For instance, a nutritional education campaign has been initiated, with elements including (Karthikeyan and Raghavan, 2017b):

- Developing a music album of motivational songs on health benefits and other virtues of SM, in Tamil.
- Developing ten episodes for a Tamil radio programme covering the history, health benefits, cooking methods, cultivation practices, and need for revival of SM; using methods such as drama, speeches, cooking sessions, interviews, and songs. These were broadcast by 33 community radio stations across Tamil Nadu, seven of which repeated broadcasts more than twice in the first half of 2017. Both the radio stations and listeners have given positive feedback.
- Campaigning to motivate consumption in two production areas of Tamil Nadu — Jawadhu Hills and Anchetty, reaching 2340 students and 530 adults in 15 villages.
- Value-addition demonstrations in Tamil Nadu and Odisha, reaching 4706 women, 712 men and 567 children in 186 locations urban, rural, and tribal.
- Telecasting SM recipe films in two locations in Tamil Nadu in order to popularise and build cooking skills.
- Sharing motivating messages on SM through 85 wall murals in nine villages in five districts of Tamil Nadu.

They have also promoted SM consumption through their work with DHAN's women's federations. These federations are one of DHAN's flagship programmes: for a description, see Annex Box A2. The federation visited

[14] Finger millet has received more attention than other varieties; CIDA (Canadian International Development Agency) in fact set up a research station many years ago. The current CIFSRF project builds on an existing legacy, albeit after a long period of neglect.

in Salem, where the programme started in 1999, covers nearly 40,000 families, rural and urban[15].

In its health stream, the Salem women's federation works with nearly 13,000 adolescent girls (3k members, 10k non-members), including testing their blood[16], providing them with supplements, SM, and some greens.

Using the federation's own savings, they have since 2013/14 procured around 156.5 tonnes of SM rice (80T in the last year)[17], distributed four kg to each member annually (1kg each of four types of SM — a demonstration quantity to accustom members to the taste), and supplied pamphlets with SM recipes. They also make SM available in their two shops (one in the office, one in town), where they sell cold pressed oil, coconut and other edible oils, jaggery, SM, and rice flakes.

Another notable activity here, influenced by SUSM among other millet advocates, though carried out by the state government, was a pilot to include sorghum and finger millet in Karnataka's Public Distribution System. This trial begun in 2013/14 and went to 2015/16.

While the incorporation with DHAN's women's federations appears very successful, some other elements inked to the project aimed at boosting millet consumption have hit stumbling blocks. The pilot trial to include finger millet in Karnataka's Public Distribution System– while a monumental achievement in many ways given the scale and intractability of the PDS system — unfortunately initially failed as the procurement price was set too low and farmers simply sold most of their SM to the open market. Moreover, farmers felt the government did not pay promptly enough for what was procured — particularly compared to much shorter times taken to receive payments when selling to traders from the threshing floor (Rajshekar and Raju, 2017). Finally, what little was available on PDS was also criticised by some as poor quality (ibid).

Without full government buy-in, including the setting of realistic procurement prices, such schemes will not be successful. If efforts persist and manage to include millet in India's PDS however, damage done by decades of policy neglect against this traditional crop may start to reverse.

Secondly, one of the project's original proposals— to include SM in the free school meals of the Akshaya Patra Foundation — became impossible, owing to cost constraints of the foundation in question. Millet is quite a bit more expensive than rice or wheat, and they felt they could not absorb the extra cost at this time. The TNAU has however drawn up a proposal, submitted to the Tamil Nadu State — to include SM (biscuits) in state-wide school feeding programmes (TNAU, 2017). If successful, such an activity could significantly boost consumption and generate new, sustainable demand for SM producers.

Capacity and behaviour changes

Women in DHAN's Salem federation started learning about the SM in first phase of the CIFSRF project (in 2011). Some members already know about millet — mostly the older ones; there is less awareness in younger generations, and children are largely unaware.

The federation also works with nearly 20 primary health centres, travelling weekly to provide training to pregnant women around diets and personal hygiene: small millets have been incorporated into this training. Training of trainers — clinic staff — has also included training on small millets, with around 30 staff being trained. Furthermore, the federation advocates for healthy eating in schools — discussing benefits of millet as well as providing vegetable seeds for a kitchen garden programme (to adolescent girls[18], schools, and police stations). In addition, since the advent of CIFSRF, the federation has organised a walkathon to raise awareness about SM every two years. This takes place on the same day in about 25 locations and attracts considerable media attention (DHAN Foundation, 2013).

The federation leader is an extremely strong millet advocate: having integrated SM into their programme, not just in advocacy, shops and distributions, but in the snacks at every federation meeting, the meals for their staff's quarterly training sessions, as well as in her own household. She mentioned that her children, (grade 2 and 11) will get SM to eat '*whether they like it or not*'.

[15] So far as a federation it has saved 500M rupees and mobilised 6,000M rupees from banks. In 2017 it provided life insurance for around 70,000 people.

[16] In their tests for anaemia, 6 months apart, they have seen improvements. Generally moderate rates of anaemia are around 10%, severe rates less than 7% and extreme rates 4%.

[17] Procured through the business arm of the DHAN foundation (some 12T came from the Periayur FPO visited in the field), they have purchased the less polished variety which retains more bran and nutrients.

[18] If children are in households without gardens, they also demonstrate how to grow vegetables in pots.

Gradually they are getting used to SM versions of traditional food items such as dosas and idli.

The federation leader estimates about 20% of members are more regularly taking SM as a result of the efforts of the programme. Some members we met with mentioned they are diversifying their grains. Where before they were all taking rice, now they eat sorghum, maize, wheat, pearl millet, and SM.

Asked about changes in their consumption over the last five years, federation members interviewed felt they had boosted their millet consumption, incorporating it into traditional diet elements, as well as more novel snacks. They have tried different kinds of recipes from the DHAN/TNAU pamphlets; mixed it with of rice or pulses, and also new kinds of foods. For Diwali, for instance, they make millet sweets.

One woman gave the example that, where before she might have cooked two cups of rice, now she will cook one cup of rice with millet added. Much of this increase in consumption has been of major millets (sorghum and pearl millet), but the women say they and their families are also eating more SM. Five years ago, these were not readily available in the shops, and now they are, particularly finger millet.

In terms of their motivations, some of the women mentioned that it is important to them and their families that millet is a chemical-free food: rice uses far more chemicals in production. Some remember that they used to eat more millet before, and were healthier; they want to return to these times. While they encourage children to take millet rice, children tend not to like it that much. For this reason, they try to get children to eat millet in the form of snacks. They also encourage children to eat it using rhymes or songs, plus some videos that are available on the internet.

While millet is more expensive than rice, rice prices have also increased over the last 4 or 5 years, so the margin over rice is smaller. For example, rice might be 50 rupees, millet 70 (per kg), so the margin is small. Moreover, millet is more filling, so less of it is needed to feel full, compared to rice. Several women mentioned this issue of millet being more satiating. One said, '*If you have to cook one kilogram of rice, you can cook half a kilogram of millet, to get the same level of satiety — especially with Koda millet.'*

Millet is not the only constituent of their families' diets which has changed over the last five years. In particular, their children are eating more packaged Chinese style instant noodles, burgers, pizza, and KFC-style fried chicken. People are purchasing snacks outside their homes more often, as well as buying more packaged products.

One woman joked the researcher from the UK should return home and '*…share South Asian food with the west — so westerners can learn about good food and stop sending this fried chicken junk that the kids have become crazy about!*'

Results

The project has certainly boosted millet consumption — among poor and non-poor consumers.

Moreover, the millet produced by the small-scale dehullers is less polished than that from more industrial processors, and richer in micronutrients than its competitor, rice. Not only is it higher in iron and calcium, it is also better in terms of protein, fats, and fibre.

Studies by TNAU and McGill to assess health benefits of SM are ongoing. Bioavailability studies of the SM based therapeutic foods developed by TNAU showed they are suitable for diabetic patients, and those with cardiovascular diseases, while they can also be recommended to children and geriatrics. The products were shown to have potential to reduce LDL cholesterol, increase HDL cholesterol[19], and prevent formation of carcinogenic compounds. Work to evaluate the quality of proteins in SM by McGill University is ongoing (Karthikeyan and Raghavan, 2017b).

Impacts

Benefits to consumers of SM, while understood in theory, are more difficult to observe in the field. Some women in the Salem federation, as well as some of the farmers interviewed felt their increased consumption of SM was influencing their health in terms of blood sugar control.

Women in the Salem federation have also noticed that when they eat millet they don't become hungry soon — it stays in the stomach a long time. There is a slight disjuncture between millets being marketed as a healthy/therapeutic food, and the number of millet sweets and treats relatively high in sugar on offer. Natural sugar is often used in place of refined sugar,

[19] Cholesterol is carried in the blood attached to proteins called lipoproteins. There are two main forms, LDL (low density lipoprotein) and HDL (high density lipoprotein). LDL cholesterol is often referred to as "bad cholesterol" because too much is unhealthy. HDL is often referred to as "good cholesterol" because it is protective (HeartUK, 2017)

being seen to be healthier, but the resulting snacks remain very sweet. That said, the cookies aimed at children were not overly sweet.

3. Assessment

3.1. Sustainability and scaling up

3.1.1 Sustainability

From the field assessment, this project would seem to score highly on sustainability. The machines are not likely to break down and sit idle, unrepaired. Machine manufacturers are all either longstanding viable businesses, or those run by experienced engineers. All take care to manufacture quality machinery — one even has a dedicated quality control worker. Each has systems in place to properly set up machines for buyers, to train machine users about operation, maintenance, and if necessary, repair, and to offer warranties and spare parts. AVM Engineering Industries for example has a one-year warranty on their machines and several services including delivery to destination, with a technician remaining in place for a minimum of two days to fix the machine and train users in operation. The technician also travels once every three months to service the machine — this service is free and machine buyers have only to pay for replacement parts if needed.

The **millet foodstuff producers** SUSM works with are predominantly existing businesses or businesses run by people who are very keen to enter and remain in the SM market, seeing it as a growing business opportunity. Changes occasioned by the project in these producers, such as use of more sophisticated packaging techniques or the entry into more markets are likely to persist. Demand for millet products appears to be on an upward trajectory.

In Tamil Nadu State at least, **farmers** are already growing more finger millet — and perhaps more little millet and foxtail millet. If demand continues to rise among consumers, and with expansion of small-scale processing units available, it is reasonable to expect farmers to continue to choose to plant SM: perhaps even to increase them.

One of the purposes behind promoting snack production, on top of its obvious benefits for snack producers, is to generate demand for millet. The composition of snacks on offer is not seen as the most pressing concern[20].

Will **consumers** continue to seek to (re)integrate SM more heavily into their diets? Certainly the trend to see SM as a healthy snack for urban middle or upper-class people appears a lasting one: it has been building for some years. The incorporation of SM in the Salem women's federation also seems assured. The head of the federation we interviewed was a very keen advocate for millet, and sees no reason to limit her activities to the CIFSRF timeframe.

The exceptional leadership and dedication shown by **the SUSM team** also suggests positive things for sustainability. The commitment by all parties — DHAN, TNAU, and McGill University to SM is clear. McGill University's work around millet content and processing is embedded in as much as it is driven by the personal interest of Prof. Raghavan, and the interest of many of the masters and PhD students there enrolled. TNAU has developed many SM production techniques and has integrated it well into the broad food processing training it offers. DHAN has picked SM as an area to champion, and they are setting up a 'Small Millets Unit' within DHAN to take forward their work. This thematic support by DHAN assures they will spend around 4 or 5 years developing a model before graduating it, spending 8 to 10 years trialling it in different contexts and perfecting it. They have already attracted support from funders like GIZ for another large-scale SM project totalling around US$2.2M.

3.1.2 Scaling up — to date and future potential

To date the project appears to have been largely successful in the scale up proposed, helping large numbers of micro- and small enterprises produce (healthier) millet products, improving sales of SM processing machines, and reaching large numbers of new consumers with SM, as well as potential customers with information about SM (Table 6).

[20] The integration of millet into biscuits is more about raising awareness of millet and boosting sustainable demand for farmers than the health of the biscuit consumers. The amounts in biscuits are seen as too small to greatly influence micronutrient intake:

"But are these packaged offerings healthy? DHAN Foundation's M Karthikeyan believes not. "While they've created awareness about millets, they bring no change due to the negligible percentage of millets used. For a real difference in health, millets must be consumed as the main ingredient in the diet as roti or rice" (Khandelwal, 2017)

Reaching the poor

Most of the millet products promoted by DHAN are aimed at middle-class consumers, with the exception of millet porridge and some of the individually wrapped millet cookies which are priced and branded attractively to school children.

This project works on getting millet into the hands of the poor, through two avenues. The first through its synergies with the DHAN women's federations. The second avenue is through farmers retaining more millet for own consumption.

This project scores highly on potential for further scale up. DHAN's women's federations, for instance, present a significant avenue for scaling up. They exist in 14 states, with a total of more than 900k households; they plan to enrol a further 500k over the next 5 years, as well as to start incorporating their millet promotion into the federations more widely.

TNAU's proposal to incorporate SM into school feeding programmes Tamil Nadu-wide (TNAU, 2017) is another scaling opportunity.

Furthermore, if the teething problems with incorporating millet into the PDS system seen in Karnataka can be overcome, great potential exists there, and in other states. These potential leaps for SM depend a bit on generating government buy-in. A recent announcement by the agriculture secretary suggests this may be close to assured, with the national government reportedly planning to include one variety of small millet (finger) more widely in the PDS systems nationally — see excerpt in Box 4

Box 4 Plans to include major and finger millet in school meals and PDS system

THE INDIAN UNION government proposes to include coarse grains such as jawar (sorghum), bajra (pearl millet) and ragi (finger millet) into the midday meal program in schools and also distribute it through the government-subsidised food program, the public distribution system (PDS), agriculture secretary S.K. Patnaik said recently.

This announcement comes five years after the introduction of the National Food Security Act, which provided for the distribution of millet – once a staple in the Indian diet. PDS beneficiaries, 813 million of India's poorest people and roughly 75 percent of its rural population and 25 percent of its urban population, will get millet at 1 rupee [2 cents] per kilogram.

Until now, only a few states such as Karnataka and Tamil Nadu had made millet available, and only in certain pockets.

However, the government will give millet a makeover before making it available through the PDS. "Instead of distributing millet as a coarse grain, the government proposes to bracket it in a new 'nutri-cereals' category," Vilas A. Tonapi, director of the Indian Institute of Millets Research, told IndiaSpend.

Source: Excerpt from article by Bahri, 2017, https://goo.gl/fGdRAr

Table 6 Roundup of key achievements of SUSM to mid-2017

Partnerships with equipment manufacturers	5
Tonnes of additional bulk SM products (rice and grits)	260
- Across how many states	7
- To how many consumers	90,000
Operators of SM Processing Units trained	34
Local mechanics trained	8
SM food enterprises with DHAN/TNAU working relationship	48
- In TN increased scale of operation (reach to new districts)	24
Pushcart Millet Porridge Vendors supported in Madurai and Krishnagiri	92
- To follow food hygiene/safety practices	70
- To apply for FSSAI registration	30
- To apply for biometric cards	55
- To improve visibility	24
- To diversify into other millet snacks	12
Micro enterprises offered customised training in Odisha /AP - 58	58
- Of which have started selling SM food products	8
- Of which are canteens introducing SM into menu	2
Episodes of a SM radio programme in Tamil developed - 10	10
- Community radio stations across TN broadcast them	33
- Of which this many have repeated broadcasts	7
Cultural programme promoting SM consumption reached	
Students	2340
Adults	530
Villages	15
Value-addition demonstrations in TN and Odisha reaching	
Women	4706
Men	712
Children	567
Villages	186
SM recipe film telecasts	2
Wall paintings sharing motivating messages on SM	85

Source: Extracted from Karthikeyan and Raghavan, 2017b

The potential is clear — for millet to transition from a neglected inferior crop to a highly desirable healthy food, in India, and perhaps beyond. Will millet be 'the next quinoa?' — coming from relative obscurity (at least in most western countries) to presenting itself in supermarkets and on menus everywhere; some think it possible. The team is well-placed to further this.

3.2 Specific outcomes

Food & nutrition security

Improved nutritional status and health, particularly for pre-diabetics, is expected where people are replacing traditional cereals such as rice with small millets.

For farmers, choosing to produce more small millets means retaining cropping systems that are diverse, potentially improving availability of other micronutrient-rich food among farm families.

Other significant changes in contributors to people's diets and health are taking place in parallel. More rural people for example are accessing piped water and improved sanitation, while diets are shifting to include more processed and western style foods.

Income

Significant improvements to incomes of machine manufacturers, as well as millet foodstuff producers have been realised through this project. For some of the food producers, income improvements likely represent a significant share of household income; for others they are more marginal.

Income impacts for farmers are likely marginal. Farmers are however not a focus of this phase of the project.

Sustainable agriculture

The agricultural aspects are not a focus of this phase of the project. Millet is however a low-input crop, traditionally produced in mixed cropping systems.

Gender

One key element driving this programme was the desire to reduce women's drudgery in hand processing SM through proliferation of small-scale mechanised processing units for SM. Certainly production and use of such small-scale dehullers has been boosted — with women who live within ready access to processing units most likely to benefit.

Other aspects of gender or women's empowerment influenced through this programme are more clear — namely the support to micro- and small enterprises that are largely run by women (or partially run by women in collaboration with other family members). Capacity and opportunities of these women have been significantly boosted through SUSM.

In parallel, delinked from SUSM, support to women from the state — notably tax incentives for female entrepreneurs, as well as direct subsidies in terms of lower interest rates on loans (with some state credit funds earmarked for women), and huge subsidies for participation in trade fares — is helping women-owned micro and SMEs. While SUSM is not responsible for these state initiatives, DHAN has helped some of their food processing beneficiaries to understand and access the state help available.

3.3. Research partnership and policy influence

3.3.1. Research partnership

The team assembled for this project are exceptional. Though a longstanding collaboration exists between all parties[21], they have come together in a new way through SUSM. As a whole, the team is well suited to the work required, having highly complementary capacities and motivations.

The focus of McGill staff and students, led by principal investigator Professor Raghavan[22], is on researching, developing, and analysing useful technologies and methodologies around millet and associated foods. They work for instance on processing techniques such as popping, malting, and their impacts on bioavailability of nutrients, on improvements for dehulling techniques to avoid over-polishing grains and retain nutritious bran, and on fortifying common foods with millet. Currently, the CIFSRF project is enabling study on protein content and analysis of SM.

At TNAU, which also carries out research, the technologies and techniques developed in McGill and TNAU research settings have been further translated and incorporated into practical training sessions. These include courses on how to prepare millet-based therapeutic foods; courses on processing techniques such as flaking, popping, baking, and so forth.

Finally, DHAN, with its wide reach on the ground, and its advocacy and self-help experience acts as an interface between the science of McGill/TNAU and both the awareness and practical needs of target beneficiaries, including small and medium enterprises in equipment manufacture and millet foodstuff processing, as well as members of the public more generally.

Certainly, each party in this arrangement is capable of making strong progress alone; but the sum of the partnership is far greater than its individual parts. One of the millet food producers visited in the fieldwork for instance (Shree Ganapathy Foods), was run by two young men who had taken most of the food processing training available at TNAU. They were nonetheless delighted with what was their first contact with DHAN staff, who they could see presented further opportunity for them to develop their business.

3.3.2 Policy influence

The focus of CIFSRF on influencing policy is one of its key strengths, and would not necessarily have been a key element of a project like this that was not funded under CIFSRF. A national policy workshop organised by DHAN Foundation, titled 'Mainstreaming Small Millets in Our Diets' was held in New Delhi in mid-2017, with participants from three states (TN, Odisha, and AP) and the central government attending. Other participants included: NGOs, research organisations, and funding agencies. The objective of this workshop was: "To discuss and develop concrete policy support needed for mainstreaming small millets at the State and Central Government levels" in terms of:

a) Improving production
b) Developing decentralised processing infrastructure
c) Market development
d) Promoting household consumption.

The workshop participants shared views on policy support necessary for mainstreaming SM into Indian diets, with the activity resulting in a set of recommendations to feed into existing government initiatives to promote SM, such as those in AP and Odisha, as well as a national level 'mission on millet' being contemplated by the *Ministry of Agriculture and Farmers Welfare*.

Through this exercise, the project has been able to identify several action points in order to overcome bottlenecks and hurdles in millet production, processing, and consumption. Box 5 lists the specific

[21] The McGill-TNAU formal link on food processing goes back to a CIDA project in the 1990s which involved capacity building for Agricultural Engineering programmes in India, and was followed by another project in 2002-2007 which set up the food processing incubation centre at the TNAU Coimbatore campus, and continuing with a further project between 2009-2013 under which further units at the campus, the post-harvest centre and the bakery, were developed. The DHAN-TNAU link likewise has existed for a long time.

[22] Originally from Karnataka and so familiar with the food and food security issues of southern India

policy action points for scaling up production for example.

Other policy influencing entry points have been identified and exploited by this study. For instance, the SUSM team plans to share findings from their study evaluating the adoption and impact of village-level hulling equipment on (largely female) users with government schemes for establishing new village-level SM processing units (Karthikeyan and Raghavan, 2017).

Finally, the SUSM team's links to government — state as well as nation level — enables them to directly influence government thinking on SM.

Box 5 Action points under 'Focus areas for policy action' in scaling up production identified by the project

Specific policy action points

1. Mapping of small millet production areas across the country at the micro geographical unit level like firka or sub-block for informed policy actions and better implementation.
2. Support for community Managed Seed Systems involving local farmers' organisation covering,
    a) In situ conservation of land races
    b) Participatory varietal improvement and adoption of well performing varieties through mini-kit programme
    c) Seed enterprises to meet local/regional seed demand
3. Support for increasing production covering,
    a) Reviving/promoting small millets as part of mixed/inter cropping systems and not as sole crops
    b) Research and effective adoption of region/location specific improved production practices
    c) Threshing yard construction and custom hiring services for harvesting, threshing, cleaning and grading of produce
    d) Customised crop insurance at affordable terms
    e) Diversifying cropping systems in traditional rice and wheat belt like Punjab and Haryana for addressing the malnutrition related issues
4. Support for marketing of farm produce of small millet farmers through higher Minimum Support Price (MSP) and regular procurement by the government covering,
    a) Assessment of cost of production for small millets in different production regions for arriving at support prices
    b) Fixing MSP for small millets higher than other crops to create a level playing field with other crops and production incentive for the farmers
    c) Involvement of civil supply corporation and marketing federation at the regional level to cushion the grain market and to create a sustained regional supply chain for small millets. This will address market uncertainties and make possible other large-scale measures like inclusion of small millets in public food programmes.
    d) Support for aggregation of the produce at the local level through farmers' organisations
    e) Creation of decentralised warehousing and procurement facility with stock based credit support
5. Need based credit support for small millet cultivation.
6. Agency: Support for organising small millet farmers in to effective farmers' organisations like FPOs and supporting them for organised production and marketing.

Source: DHAN Foundation, 2017

SUSM contribution to India's small millets revival

In terms of the project's contribution to furthering the cause of SM: it is one among many initiatives supporting and developing India's SM sector, but it is well integrated with SM initiatives in universities and NGOs, as well as being linked to industry and government actors.

Dr. Raghavan of McGill University for example has worked with staff of the University of Agricultural Sciences at Bangalore, and at Andhra University on millet-related projects.

The SUSM team is also well aware of and supporting the work of other NGOs on SM, notably the MS Swaminathan Research Foundation (MSSRF), well-known for its involvement in promoting millet[23].

[23] MSSRF was also involved in advocating for the government of Karnataka's introduction of sorghum and finger millet into PDS schemes. Rajshekar and Raju (2017) reported that Professor Swaminathan had recommended that procurement prices be set with at least a 50% margin over costs of cultivation for example.

Links to food industry on small and large scales allow the SUSM team to understand what industry identifies as the biggest gaps and needs. The proprietor of Sri Venkatachalapathy rice mill, interviewed as part of the fieldwork for instance identified a lack of standardisation for millets (as exists for rice and wheat) as a key hurdle, together with lack of scientific knowledge around millet processing, and the cost of testing products for nutritional content.

Though its contribution cannot be quantified, clearly this is an important project, contributing to popularising millet, as well as bringing about substantial improvements all along the millet supply chain.

References

Bahri, C., Aug 8, 2016. A millets revival could solve India's malnutrition problem. Scroll.in article accessed Dec 2017. https://scroll.in/article/813413/a-millets-revival-could-solve-indias-malnutrition-problem

Bahri, C., Dec 11, 2017. India's Millets Makeover. Set To Reach Poor, School Meals. IndiaSpend Article, Online. Accessed Dec 2017 http://www.indiaspend.com/cover-story/indias-millets-makeover-set-to-reach-poor-school-meals-36491

DHAN Foundation, 2013. Small Millets Inspire Thousands to Walk for a Cause. Article. Online. Accessed Dec 2017 http://www.dhan.org/developmentmatters/2013/february/case1.php

DHAN Foundation, 2017. National Policy Workshop on Mainstreaming Small Millets in Our Diets: A Synthesis of Policy Recommendations Annex 2.4 in *Scaling up Small Millet Post-harvest and Nutritious Food Products Project: Third Interim Report.* DHAN Foundation, McGill University, and TNAU. Technical Report.

FAO, 1995. Sorghum and millets in human nutrition. Food and Agriculuture Organisation of the United Nations, Rome. http://www.fao.org/docrep/t0818e/T0818E00.htm#Contents

HeartUK, accessed 2017. Cholesterol — The silent killer. Web article. https://heartuk.org.uk/health-and-high-cholesterol

IDRC, 2015. Scaling up small millet post-harvest and nutritious food products (CIFSRF Phase 2) Project Approval Document.

Karthikeyan, M, and V. Raghavan, 2017b. Annex 2.1: Progress towards milestones - December 2015 to June 2017 in *Scaling up Small Millet Post-harvest and Nutritious Food Products Project: Third Interim Report.* DHAN Foundation, McGill University, and Tamil Nadu Agricultural University. Technical Report.

Karthikeyan, M., 2017. Scaling up research-for-development initiatives on small millet production and consumption across India. Presentation. DHAN Foundation.

Karthikeyan, M., and V. Raghavan, 2017. Scaling up Small Millet Post-harvest and Nutritious Food Products Project: Third Interim Report. DHAN Foundation, McGill University, and Tamil Nadu Agricultural University. Technical Report.

Khandelwal, H., Oct 8, 2017. Thoroughly Modern Millets. DNA Article online. Accessed Dec 2017 http://www.dnaindia.com/lifestyle/report-thoroughly-modern-millets-2551181

Mayne, J., 2016. An Example of ToC Analysis. Working Paper.

Nagarajan, L., P.G. Pardey, and M. Smale, 2006. Local Seed Systems for Millet Crops in Marginal Environments of India: Industry and Policy Perspectives. IFPRI EPT Discussion Paper 151

Rajshekar, S.C., and S. Raju, 2017. Introduction of Millets in PDS: Lessons from Karnataka. Report. LANSA MSSRF. http://59.160.153.185/library/sites/default/files/Millets%20in%20PDS%20Study.pdf

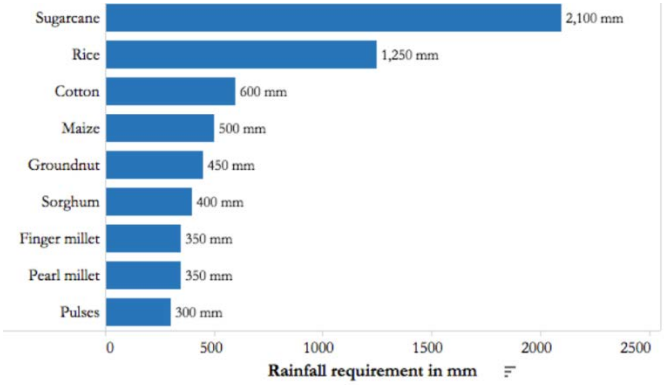
Rava, J. Nov 22 2017. India requested UN to decleare 2018 as International Year of Millets. Article. Eastern Eye. Online, accessed Dec 2017: https://www.easterneye.eu/india-requested-un-declare-2018-international-year-millets/

TNAU, 2017. Proposal for introducing millets in nutritious meal scheme of Government of Tamil Nadu. TNAU Report. Post Harvest Technology Centre.

Annexes

A: More detail on the project, its context, and emerging results

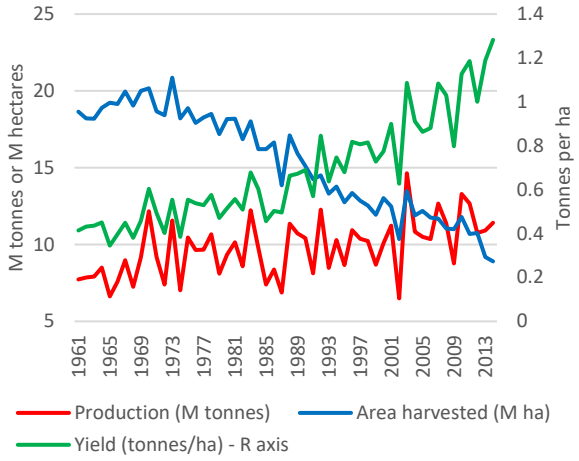
Figure A1: Rainfall requirements of millet compared to other crops



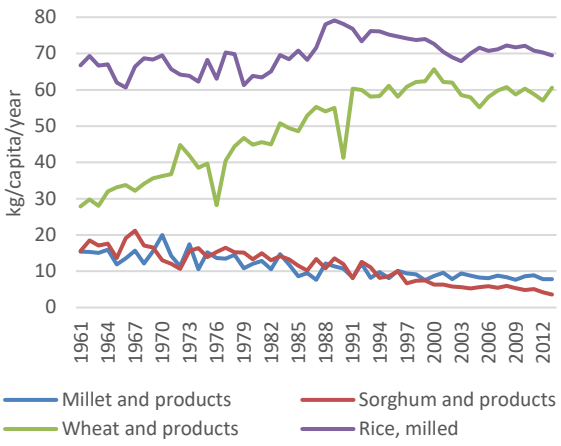
Source: Bahri, 2016

Figure A2 Production and consumption of millet in India: 1961-2014

a) Millet production, area, yield: India, 1961-2014



b) Per capita supply of key cereals in India, 1961-2013



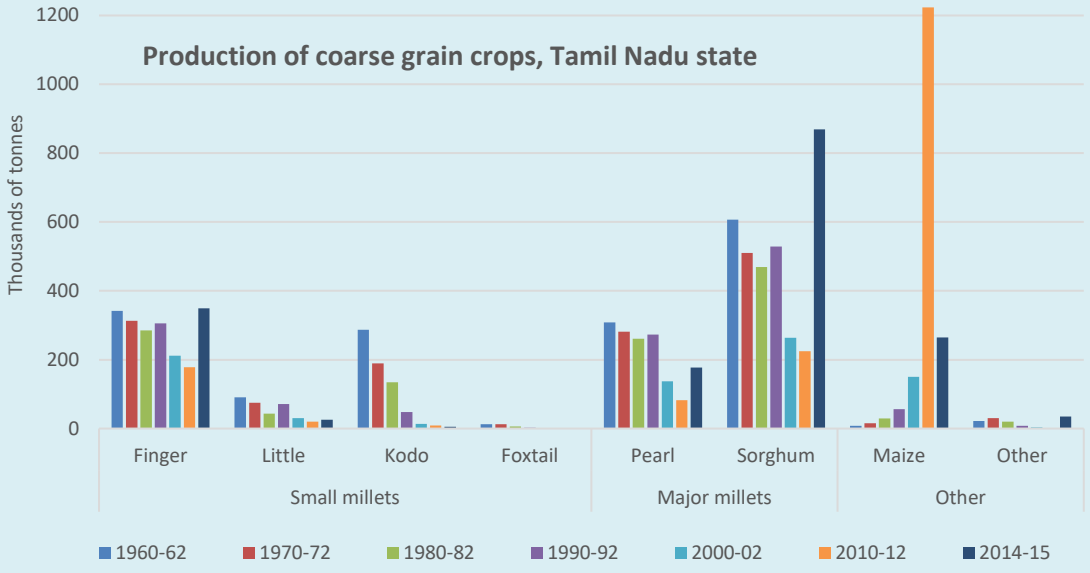
Source: Data from FAOSTAT. Note: 1 As aggregate figures, these hide variation between small and major millet (likely include pearl millet but not sorghum as FAO records this separately), and between the six major small millet crops.

Box A1 Ten-yearly trends in production and area of key crops in Tamil Nadu: 1960-62 to 2010-12, and 2014-15

Production of small millets fell steadily in Tamil Nadu from the early 1960s through to the early 2010s – but in some varieties, there has been an upswing in 2015-15 – most notable in finger millet, but also there in little millet, and perhaps even foxtail. Major millets too have seen a revival, with pearl millet in 2014/15 reversing a six-decade long decline, while sorghum appears very popular of late.

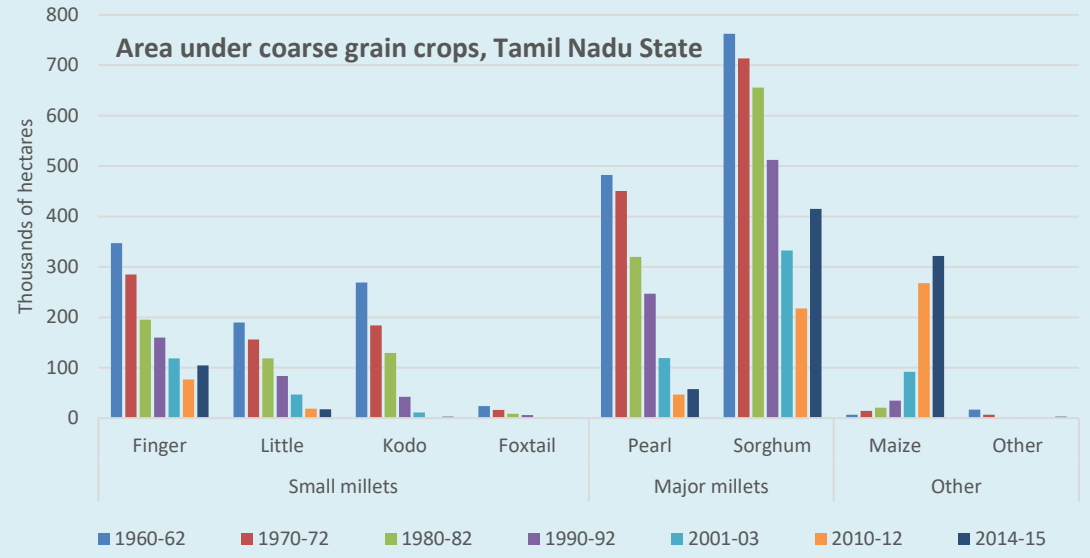
Popularity of sorghum was evident in the fieldwork, with plenty of thriving sorghum visible. Farmers interviewed also commented on sorghum – and sometimes maize – as main competitors for millet in their planting decisions, particularly as fodder from sorghum is increasingly lucrative, while sorghum is also comparable in drought tolerance to some of the small millets.

a) Production in k Tonnes – figures below graph



	Small millets				Major millets		Other	
	Finger	Little	Kodo	Foxtail	Pearl	Sorghum	Maize	Other
1960-62	341.45	90.54	286.87	12.79	308.673	607.267	7.51	21.455
1970-72	313.003	74.75	189.267	12.22	281.61	510.583	15.617	29.937
1980-82	285.13	42.95	134.08	6.517	260.58	469.26	29.267	20.22
1990-92	305.95	71.063	47.67	2.66	273.05	529.207	56.137	7.766
2000-02	211.656	30.625	13.998	0.754	137.341	263.884	150.008	3.599
2010-12	177.989	20.46	8.606	0.365	82.773	224.823	1223.122	0
2014-15	349.628	25.264	5.498	0.518	177.57	868.98	264.751	34.923

b) *Area in k hectares – figures below graph*



	Small millets				Major millets		Other	
	Finger	Little	Kodo	Foxtail	Pearl	Sorghum	Maize	Other
1960-62	347.285	189.706	268.69	23.91	482.657	762.216	6.853	16.816
1970-72	284.795	155.809	183.976	16.075	450.497	713.329	14.38	6.865
1980-82	194.984	118.306	129.022	8.855	320.022	655.829	20.486	0.988
1990-92	159.551	83.654	41.982	6.033	246.544	512.349	34.85	0.413
2001-03	118.733	46.373	11.12	1.547	118.789	332.796	91.826	0.344
2010-12	76.249	18.584	0.517	0.783	46.358	217.351	267.39	0

2014-15	104.426	17.401	2.646	1.057	57.708	415.103	321.982	2.726

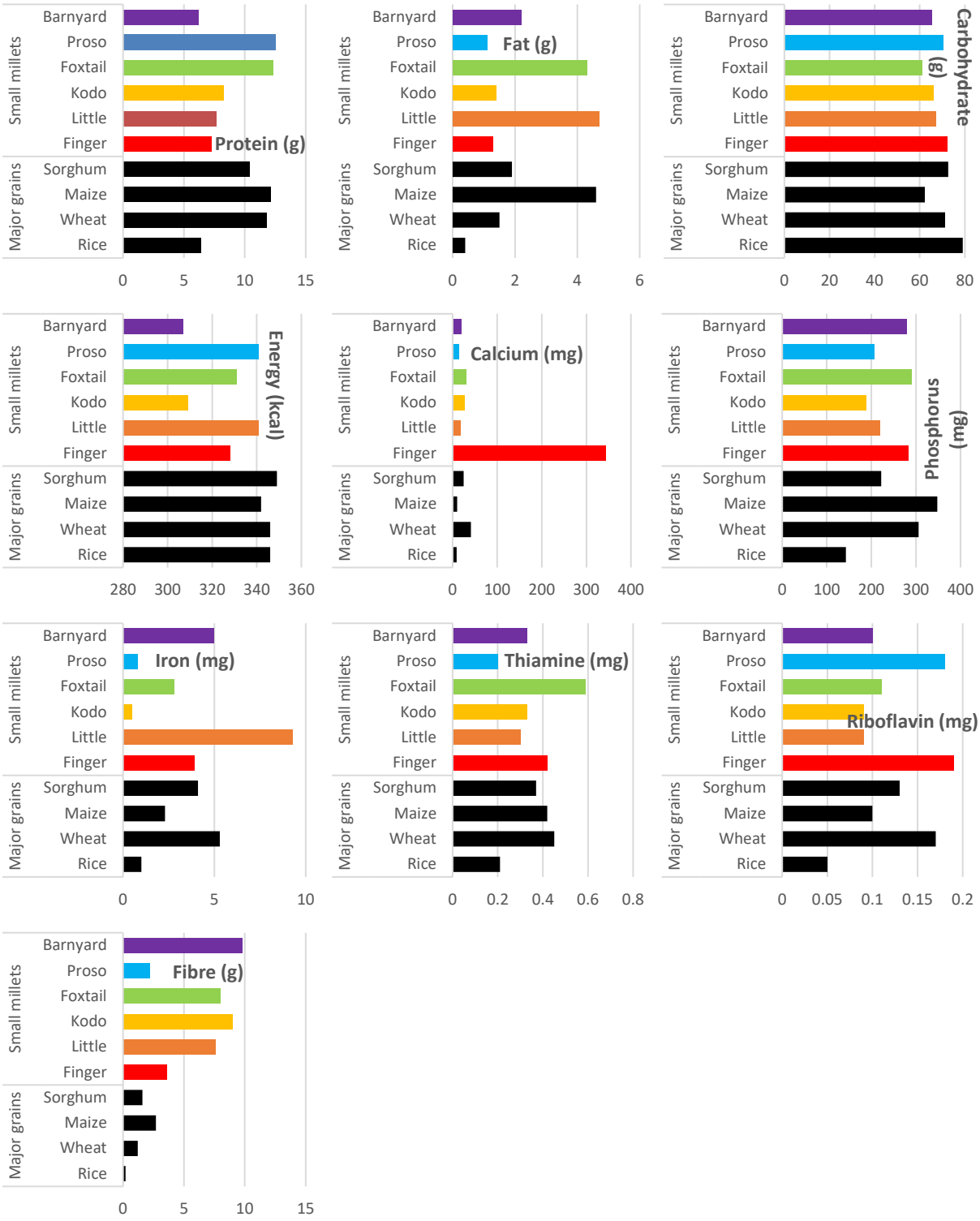
Source: Compiled by J Jeyaranjan from Season and Crop Reports, Department of Statistics, Government of Tamil Nadu.

Table A1 Focus groups and Key Informant interviews held in October and November 2017

Stakeholder	Type of interview	Notes
Farmer producer organisation members (including millet farmers)	Focus group discussion	One group in Periayur (8 participants)
Millet farmers	Focus group discussions (mainly women)	One group of women near Sengapadai (20 participants)
Millet food product businesses	*Key informant interviews*	*Operating on different scales – see below*
Micro enterprise	Key informant interview	One wife and husband team in Madurai (2 participants)
Small/ Medium enterprises	Key informant interviews	Six in Madurai and surrounding towns; Five in and around Coimbatore (one or two participants per interview)
Large enterprise	Key informant interview	Company owner in Tiruchirappalli (1 participant)
Machine manufacturers	*Key informant interviews*	*Operating on different scales – see below*
Small-scale	Key informant interviews	AVM Engineering Industries and Victor Agro-Sales, Salem (1 participant)
Medium scale	Key informant interview	Perfura Technologies, (Sree Venkateswara Engineering) Coimbatore (1 participant)
DHAN Women's federation leader in Salem	Key informant interview	To get a sense of potential scale up through synergies with DHAN's work on women's federations (1 participant)
DHAN Women's federation members in Salem	Focus group discussion	With one group in the Salem Federation (25 participants)
DHAN staff	Key informant interviews, unstructured discussion	Meetings with senior DHAN staff in their offices in Madurai, as well as discussions with the Prinicipal Investigator of SUSM and other members of DHAN staff involved in implementing SUSM. (9 participants)
Tamil Nadu Agricultural University (TNAU) staff	Key informant interviews and informal discussion at TNAU campus	Dr. N. Varadharaj, Head of Department, Dr. D. Malathi, Professor of Food Science and Nutrition, other staff members involved in crop science and nutritional content analysis. (2 participants)

Source: Authors

Figure A3: Nutritional content of small millets compared to major grains



Source: National Institute of Nutrition - Hyderabad

Table A2 Profiles of machine producers visited

Name, place	Age	% millet	Machinery	DHAN/ TNAU help	Future plans	Sales/ growth in 5a	Cost/other changes
AVM Engineering Industries, Salem, Tamil Nadu	Been in the business for >30a. Focus on millet machines over the last 15a	Almost entirely specialised in millet machines now	Most machines double chamber 100/200kg/hour capacity. Made a 2.5M rupee investment in 4 chamber model: sold 12 units around India (does 750kg/hour – TNAU technology but they have innovated to add chambers). Specialise in conveyer style machines (clean, destone, grade in one). Has developed a special unit that will run on lower voltage available in some villages where basic services lacking	Started in 2013 with DHAN. DHAN helped them win the contract to supply 35 machines to Andhra Pradesh state scheme. DHAN helped advertise widely including Odisha, Andhra Pradesh, Madhya Pradesh, Karnataka. Put their name in brochures at exhibitions, helped enrol in online sales. Multi-party assessment helped improve machines (e.g. safer, easier to use, resolve tech issues like rubber wearing, heat generation)	Planning a dehuller to do 2000kg/hour. Move to a larger workshop to be able to produce more (with 3 shifts in current space cannot meet demand). Work on a thresher with attachment to huller (use same motor) for cleaner threshing**	After involvement with project done 50 big units. In 2012 had only a single-chamber machine (50/100kg/hour). Sell both small and large depending on orders. About 75% small, 25% big in last two years: never did big machines before.	In last 5 years, labour costs increase >50%. Recent tax structure change increased costs. Steel for casting has gone up. Earlier 6 workers, now 20. Market price not gone up but volume of work increase. New supervisor for quality control. Staff who know different languages for marketing in different states, accessing gov't schemes. Concerns in 2012 about company future but owner's son will now take over; having stepped up in last 2a.
Victor Agro-Sales, Salem, Tamil Nadu	Started in 1984 (by father of current owners who are brothers). Millet machines since 2004	About 20% of business (family also has a shop where they sell millet and some other foods)	Millet dehullers, Groundnut decorticators, mini flour mills. Have a very quiet, quite small single-chamber dehuller; Large (but quiet-running) 4-chamber machine. New machine to separate product to 3 instead of 2 – hulled, unhulled, and broken	Marketing, R&D, links to buyers, stalls at events, participation in 3 trade fairs where they displayed machines, Advertising in other states: Orissa, Uttaranchal, Madhya Pradesh. Help preparing a flyer. Feedback from DHAN/team to make continual improvements. Help to try and establish a very small machine for village/home use (modelled on Japanese dehuller bought by DHAN)	Has a workshop dedicated to R&D. Making single-chamber dehuller smaller (for village/home level) without compromising on capacity. Seeking to create a multipurpose dehuller works for millet and rice. Also working to improve larger model (move from 300 to 500kg capacity), work to reduce energy requirements. Trials with aluminium in place of steel; light, durable	Five years ago were selling maybe one dehuller a month; now sell 15 to 20 a year. Most sales in TN, but some have reached Kashmir, NE states of Assam, Meghalaya. (Most suppliers have their mini flour mill: he has sold 30k small flour mills so people are familiar with the brand and they get orders in that way for their other machines.)	Capacity of smaller machines has improved but price kept the same; around 55 to 60k rupees per machine. Tax structure changes have increased costs. Labour costs have also increased.
Perfura Technologies, (Sree Venkateswara Engineering) Coimbatore, Tamil Nadu	Started in 2014*; ISO certified 2015	About 50% of business	Machines for millet (4 processes: De-stoner, grader, aspirator, dehusker) Double stage centrifugal dehuller. Grain polishers Flour machines (roast, pulverise, sift, blend etc), groundnut decorticating, oil pressing.	Participation in trade fairs. Participation in capacity building programme of TNAU/DHAN – attending the university for training. Purchase of licenses to manufacture products from the universities (royalties per machine of 5 to 10%). Marketing registered online in Indiamart etc.	(Not as much R&D on millet machines as previous two but more sophisticated marketing) Plans to expand the business as they are growing very rapidly	When started, worked on customised machines for each buyer, but now produces standardised ones. Company became well-known in a short period of time. Sold around 10 millet double stage dehullers this year. Won orders to provide machine	Raw material cost increases from GST changes; Taxes on motors and steel sheets have gone from 5% to about 18%. Workers (3 regular, 10 day labourers) salaries have gone up (started on an average salary of around 350 but now they pay up to 700 per day, about CAD7 to CAD14). Machine costs have gone up but profits remain the same. Also

					to 12 hubs under a project funded by TN gov't.	provide 3 services a year and have a separate service team.

* Director a mechanical engineer worked in production in Australia. Father was also in the business. ** Currently threshing by tractors driving over the material is common but threshing floors are not properly prepared, with scope for contamination for instance from soil particles.

Table A3 Profiles of millet foodstuff producers visited

Name	Brief profile	From DHAN/TNAU	Changes in practice	Sales	Costs	Future plans
Millet porridge vendors	Wife and husband vendors of millet porridge and accompaniments from their roadside cart, Madurai. Two types of millet porridge are the main business, accompanied by side dishes. They use earnings for their subsistence.	Working with DHAN over the last 3 years. 2 to 3 rounds of training on hygiene. Hygienic water dispenser. Help getting FSSAI certificate for food safety from authorities, displaying self-commitment statements on the cart around food safety and hygiene.	Use of aprons, not contacting porridge with hands, not reusing oil for frying, cleaning the area around the food cart, covering the pots of food, using the hygienic water dispenser. Displaying health benefits in front of the cart, displaying food safety certificate.	In summer (peak season as millet porridge seen as a 'cooling' food), earn around 450 rupees a day; in lean season around 250 rupees. Sell porridge for 10 rupees per pot.	Millet costs have gone own; earlier she was paying 36 rupees/kg millet; plus 5 to pulverise; now pays 26 rupees/kg, same to pulverise. Spend about 200 rupees on millet, 150 for side dishes every 5 days.	To continue to follow the food safety practices (she will renew the FSSAI certificate each year). May add more side dishes.
Atchaya foods and 'Health: Dry fruits & millets' or 'Honey and Foxtail millet'	Small-scale enterprise, started 7 years ago by a wife and husband team. They have a separate manufacturing unit and recently opened a canteen selling products in the evenings (4 to 9:30). They produce products for themselves but also for other brands (they send the material to other brands in packets who market it under a different name). 16 health-mix products plus 10 soups using all 6 small millets as well as pearl millet and sorghum.	DHAN training through a college in Madurai (part of TNAU); one week of training in how to make own products. Started canteen with DHAN's help (40k rupee loan)–4 months ago. DHAN books stalls for them in trade fairs that help make business contacts. [An exporter from Chennai met through a trade fair is keen to buy from them. Also got 5 further contacts at that one fair.] 3 or 4 basic trainings from DHAN: food safety, product development, welfare, national food technology. Gave some expenses to attend a food industry exhibition fair.	The canteen was an initiative of the wife who attended the training. Registered with the industry sector as a microenterprise; they get some support every year and a certificate. They participate in a government programme focused on women entrepreneurs which enables them to access loans, subsidies on attending trade fairs.	Currently distributing around all of Tamil Nadu and also entering into Karnataka. About 1 lakh rupees per month turnover in sales (close to 2k CAD). Three years ago it was about 30k rupees, or under 600CAD so strong growth). Sells health mixes in 3 price brands: more expensive have more ingredients. About 20% profit but a large share – 10 or 15% goes as commission to sellers.	Gets raw materials from a wholesaler (DHAN tried to source from production areas and transport but the amounts required are too small). General increasing trend in raw material prices through very volatile. Government recently introduced GST which applies to products like theirs: if sales go over 5 or 6 lakh rupees it will go over 30%	Starting to sell online from next month. Their younger son is interested to join the business in the next six months. Canteen makes around 2k/evening, plan to achieve 5k.

Name	Brief profile	From DHAN/TNAU	Changes in practice	Sales	Costs	Future plans
Padma Sree Foods	Small-scale enterprise – manufacturing in the home, in Madurai. Started 5 years ago because her father had a diabetic issue. Woman owned/operated. Produces 17 items, around 10 which contain small millets. Some also include pearl millet. Started with 4 traditional mix products then slowly made the whole line.	Product development training at TNAU; traditional snacks, cookies, modern snacks, instant food mixes, extruded (vermicelli). DHAN covered her costs to attend. Therapeutic products training most recent. Providing a stall for her every year as a women entrepreneur / member to boost sales and get her contacts. Nutrient analysis and sensory analysis (palatability) of some of her products. Also hygiene analysis: out of 30 products from 12 enterprises, hers was certified one of the best. Also microbial testing and her product passed well. Training on packaging.	Since starting she has bought her own grinding machine to pulverise and make the flower; that helps otherwise she had to outsource that. All the millet products she learnt about, new forms of packaging being used, including nutrient analysis on her packaging. Contacts to new buyers; e.g. met someone who she hope will help her supply to the Chennai market. Using improved storage aluminium drum provided by DHAN.	She now sells around 15k rupees worth per month. She makes about 50% profit, but gives 25 to 35% of this to distributors.	Procures all the ingredients from a wholesaler. Procures around 100kg mix or raw materials. Some millet prices rose 3x from the time she started.	If scale of operation increases she may have to buy a roaster. Plans to expand the portfolio: whatever people demand she will provide. She wanted a place of her own for marketing but the price is prohibitive.
Green House Food Products	Small enterprise, husband and wife team (largely run by wife; husband is a teacher and is supporting her in the business) with a separate processing unit above the house. Based in Abiramam, Ramnad District. They produce 'Century' brand products – around 16 different millet-containing products. Started 6 years ago.	Advice from TNAU on health and safety for the production unit: They used to keep pigeons, were advised to get rid of them, as well as to rat- and bird-proof the area where food is stored and mixes prepared. DHAN supported them with grants and loans to help develop health mixes, providing half kg cartons for distributing to supermarkets, branded and improved packaging, bar and batch coder. Also recently sent some to the lab for nutrition analysis. DHAN provided a 30k rupee loan for them to buy a flour grinder. Printed pamphlets for advertising. Business development and marketing training – accounts and management. Total grants of around 30k, loans around 30k.	Supplies are stored behind mesh to prevent rats and pigeons, as well as in aluminium drums in a dedicated store room. Pigeons have been removed and mesh put on the windows. The type of packaging used has been improved. Book-keeping to gauge and project demand has improved. A barcode and batch coder is now used to mark packages. Some materials are also stored in aluminium tins. They started with one product but have built to 16.	Around 1 lakh rupees turnover per month; with a profit margin of about 25%.	Ingredients procured from wholesale market. Largely uses family labour	Further expansion – sales to more areas, increasing sales to supermarkets.
Green Happy Foods	A small secondary business run by a family whose main business is a print shop in Aruppukkottai, Virudhunagar district. They sought to diversify, and have family who are in the baking industry, so they decided to produce two main kinds of millet cookies in the back	Started working with DHAN two years ago. Received training on manufacturing, preservative, labelling, packing, packaging. Nutritional analysis from TNAU. Marketing support through a stall at a trade fair, and linkages to wholesale	Decided to use traditional, eco-conscious packaging for one of the biscuit brands (more geared towards adults). The other kind is more geared towards children (polka-dot packaging).	He is sometimes invited to weddings to hold a stall (for example, 1000 pieces for a recent marriage in Madurai). Also signed up to an online trader 'Tamil Snacks' and received a large order for	Millet all procured from wholesalers. Business has received two shocks: demonetisation, and new tax regime – attracts 18% tax instead of 5% because	Continual R&D to try and improve the product. Also working in marketing. In the future they plan to market it to school children as a healthy snack.

Name	Brief profile	From DHAN/TNAU	Changes in practice	Sales	Costs	Future plans
	of the print shop. Two main products – energy bars (4 kinds in a package each featuring a different millet); and biscuits - one with palm jaggery and one with white sugar. Having the millet cookies business helps them manage labour – the supply of printing work is not steady, so when there are lulls, those employed to do the printing work can make biscuits.	distributors. Marketing channels have been opened in in Chennai, Bangalore, Hyderabad.	Before DHAN he had a disorganised marketing system, without a proper plan or accounting system, but after working with DHAN he has restructured everything and has a clear business plan.	Diwali. Sales to textile mills who distribute to staff during festivities. Already has online orders for Christmas and New Year. Business has grown 3 times in 3 years. Margins around 30%; but actually get 10% because the rest goes to wholesaler/ distributor/ retailer.	it's branded. Little change in raw material costs. Business owned by the wife who gets the female entrepreneurs tax rebate	
Mothi brand millet food products	Small-scale enterprise - home-based unit run by husband and wife. They are farmers originally who got into food processing six or seven years ago. Based in Chinnathathampatti, Virudhunagar district. Make several healthy mixes, millet flour that can be used to make chapati/ dosa/ puri, millet flakes, snacks and sweets.	Started with DHAN two years ago; Support getting certificates for food safety, nutrient analysis to add to his labelling, sensory analysis (quality testing). Support with publicity – making pamphlets, stalls at trade fairs. Training for millet-based therapeutic foods and food safety & hygiene. Loan to help them get a pulveriser. Aluminium tray to mould cookies in oven.	DHAN training helped to make some of the snack mixes he now produces. Helped to train family running 'Green Happy Foods' nearby.	The sweets are selling really well to marriages and also government functions. Their sweets have even been distributed at the state assembly in Chennai. Monthly sales of around 60-70k rupees; margins of 15k rupees. Turnover 3 years ago was about half of that.	Ingredients purchased from wholesalers. Some millet prices have gone up – Koda, little, foxtail.	Plans buying a machine (otherwise they cannot scale up further) but needs to raise money. They are already unable to meet all the demand for their products which are highly sought-after.
Ramasami Chinn-ammal Trust	Social enterprise style organisation in Coimbatore. Started by a retired food science professor from TNAU; she first worked with an NGO post-retirement to learn their processes, now she runs her own social enterprise, employing vulnerable or marginalised women (based around women's self-help groups). They produce a variety of food products and have been producing millet products like multi-mixes since 2006. Products are sold through a market stall.	Attending training courses on millet foodstuff production. A grant to pay for 20% of their new mobile shop / demonstration vehicle (this is 80% financed by a loan from the National Bank of Agriculture and Rural Development). It is a mobile unit in a truck with a removable demonstration table, allowing food product preparation to be demonstrated to an audience outside the truck.	Producing and stocking more varieties of millet-containing foods including mixes and biscuits. (Unlike some of the other enterprises visited, this one is run by someone already very plugged in to the TNAU circles).	Products are sold through a market stall and soon to be sold through the mobile shop. Profits of about 20%	Now employs 10 female workers, vulnerable or poorer women, all from self-help groups and the profit goes to pay their salaries. (A few years earlier only employed 4) Ingredients are bought wholesale, sometimes at peak season when prices are low, and preserved for use at other times of year.	Plan to use the newly acquired mobile shop to sell products and do demonstrations. Expect the mobile shop will break even in 4 to 5 years.
Proteman Foods	Proteman foods - near Coimbatore – is a vermicelli producer who has been in the business since 1986. They have included major millets in the vermicelli since 2006, and small millets – finger millet – from two years ago. They produce using an extruder and sun-dry the noodles outside before packaging in simple plastic	Attending training in TNAU on millet foodstuffs and millet therapeutic foods. Attending local exhibitions, mostly catering to local market.	Now produces finger millet vermicelli. Beginning to make therapeutic millet-containing products (for diabetes). Enriching products with fibre. No change to packaging style which is traditional and simple (they prefer to keep costs down for purchasers who are	Sell the major millet noodles for 20 rupees / 80g package, small millet for 50 rupees/80g packet. Roughly 10 lakh rupees/month turnover, margin of 15%	Sources ingredients wholesale. Small millets are expensive, more than twice the cost of major millets. Packaging very simple so costs kept low.	No plans at present to expand or reach other markets. His son may join the business and if so they may make changes.

Name	Brief profile	From DHAN/TNAU	Changes in practice	Sales	Costs	Future plans
	packaging. About 20% of the products contain millet. Employs about 20 to 25 workers.		familiar with a well-known brand in the local market already). Does extrusion work for another organisation that produces cookies.		Costs increase owing to rising raw materials and labour costs. GST of 5%	
Artifood products	A very similar operation to Proteman foods, this enterprise was begun three years ago by a man after retirement (worked 30 years at a loom). It produced instant noodles in packs with flavour sachets. Instead of an extruder, used a flat-sheet machine to produce the noodles. This method of production attracts an 18.5% instead of 5% tax, and the producer has been out of operation since the tax changes (the last four or five months).	Attended training at TNAU.	Before stopped, produced instant noodles containing finger millet.	Before shut down: made about 15% profit. None at present – with changes in GST he is at too much of a disadvantage and cannot compete in the instant noodles market.	Flat-sheet extruder from China cost 5 lakh rupees. Initially attracted 5% GST but now 18.5% following changes. (Large competitors like Nestle can produce instant noodles packages for 1/10th the cost) Used to employ 10 workers.	No plans to restart – even if he increases prices by 5 rupees /package to cover GST changes, he will not be able to sell them. Retailers offer to sell without receipts to avoid the tax but he doesn't want to take the risk of having everything seized.
Shree Ganapathy Foods	Roadside shop (only around 4 months old) and fast food cart run by two young men. Producing many products including millet health-mix, millet biriyani, millet chili powder mix.	Both owners completed almost all the TNAU training programmes on millet and other foods – from baking to sun-drying, to juice. Help with marketing. They connected with DHAN for the first time when we met, and will get more help from them now.	Before they focused on running their fast food cart; now they are focusing on producing small millet products. They market some through the university and college.	Selling is their greatest challenge, particularly as retailers ask for a 30% margin. From their roadside shop they sell around 2000 rupees worth / month.	Materials from wholesalers. They promote themselves in apartment complexes but resident association asks 1000 rupees for three hours. Chain stores want 35% commission plus 2% service charges.	They are a young business with a lot of energy and have plans to expand. They are happy to have the new contact with DHAN and will work with them in future.
Akshaya food products	A larger enterprise, also near Coimbatore, been in the business for around 30 years. Originally made drink mixes since the 1980s – a famous brand called 'Ragi malt' was popular even 20 years ago, which contains finger millet. Now they have many more products (around 20) including almond, rose and pistachio milk, healthy mixes. Their health mixes contain small millets as does their dosa mix. Everything is branded 'Ragivitta' as it's a well-known brand, though not all contain ragi (finger millet).	DHAN helped make them aware of new machines, gave them marketing help, helped with techniques of manufacturing and product development. They also took out four bus panel ads for them which are expensive but good as they stay visible for months. They have also produced the same advertising in a women's weekly magazine.	Producing health mixes with small millets. After the MOU with DHAN they introduced about 8 products.	They have an extensive market 3 vehicle to take products to markets in Chennai, Madurai, etc. Their produce goes to 1,500 shops through their vehicles which go around once in 10 days. Turnover of around 10 lakh rupees/month, achieving about 10-15% profit; retailers take about 20-25%, distributors and clearing system another 10%.	Wholesale purchase of millet and other raw meterials; on credit of 25 days. When they supply they are only paid after 75 days. Employs approx. 10 people. GST changes have tightened the market; even retailers have reduced their orders.	Plans to include small millets in more items / create new items, e.g. ready-to-cook products. Also some sweets traditionally produced around Diwali using rice flour, they plan to produce using millet flour. Some larger companies have tried to buy them but they have resisted.

Name	Brief profile	From DHAN/TNAU	Changes in practice	Sales	Costs	Future plans
				Turnover has increased over 5 years.		
Sri Venkata-chalapathy modern rice mill	Huge in scale, space, turnover compared to all other units visited. Owned by a third-generation miller who has been expanding the business. Modernised the mill with almost 10M rupee investment (about CAD200k). Paddy milling is the mainstay; they also have 5 retail outlets in the city where they sell rice. Began procuring millets through wholesalers, packing and selling it through retail outlets 5 years ago. Adds value by selling millet flours. Portfolio of 62 products - flours, extrusions, cookies, roasted and pressed grains. Also make wooden-pressed cooking oil.	About 5 years ago, started attending training programmes at TNAU, DHAN Foundation etc. Altogether has attended 30 courses, learning various food processing techniques. DHAN supported him to participate in 2 exhibitions last year bearing 50% of the costs). In total he attended 16 exhibitions last year. DHAN also flew him to Delhi to present his experience in a National Level Policy Meeting.	Now they do millet bakery products. Currently they are sourced from outside to his recipes but he has placed orders for machinery; by Dec 2017 the plant will be up and running. Advertise in Exhibitions, stalls, pamphlets. They are repackaging under a new brand 'Bliss tree'; very attractive packaging that can compete with multinationals. Future plans for more advertising with launch of 'Bliss Tree' brand. In final stages of agreement with Amazon for e-commerce.	Millet whole/flour sells for Rs. 30 to Rs. 72 for 500g. Ready-to-cook products of 300g cost 50 to 75 Rs. Cookies of 125g for 45 Rs. Extrusions of 150g for 25 or 30 Rs. Millet flakes of 250g, 55 or 65 Rs. Distribute products in Tamil Nadu, Kerala, Karnataka, Maharashtra, and Andhra Pradesh, but major market is cities in TN. Business grown in past 2 years. Annual turnover around Rs. 20 million. Small amount compared to rice milling, but they are now concentrating on millet. All sold cash and carry - no credit given.	Inputs are purchased from farmers and FPOs during the season and stored. Processed when required. They do not buy from wholesalers. Prices paid for millets and received for their products have risen over the last two years.	Continues to invest and improve; Nowhere near break even but if projections are realised may break even in a few years. Demand is growing. Plan to introduce millet rusk/ palm jaggery cookies in their bakery.

Box A2 DHAN's Women's Federations

DHAN's flagship programme of women's federations exists in 14 of India's 29 states, currently including around 900,000 households. In four states, they have intensive levels of enrolment, with more than 100,000 families. In the other states they may reach around 20,000 families. DHAN's next 5-year plan (2018 onward) aims to reach an additional 500,000 women.

The federations are formed from clusters of women's self-help groups, initially formed for microfinancing purposes. Such self-help group clusters may take three years to form federations, which become sustainable within five years. The established federation visited in Salem had almost 40,000 members. Such federations are able to support members and their families with life, livestock and crop insurance. Established federations scale up community banking and allocate funds among many activities, major themes including remedial education, healthcare, or loans for sanitation and housing.

A major focus of the federations is on women's empowerment and leadership development. They provide a space for women to meet, plan, and achieve their potential, through programmes including insurance, savings, credit, and pensions.

Another major focus of the federations is on poverty reduction, and within this, on improving health, sanitation, and nutrition security. The federation in Salem visited during the fieldwork for instance promotes a community hospital. Each federation will have a primary health centre and run a small medicine shop with affordable medicines.

Within the health and nutrition strand, federations work explicitly with adolescent girls on micronutrition, especially anaemia reduction, through blood tests, health education and kitchen gardens.

Source: Communication with DHAN staff

B Snapshots from the field

B1) Wife and husband, millet porrige vendors with their roadside cart, covered food dishes and hygenic water dispenser, Madurai

B2) Husband and wife of Atchaya foods at their canteen selling ready-made millet foodstuffs outside a supermarket in Madurai

B3) Packaging from Atchaya foods millet mix, showing nutritional content

B4) Flour mill bought by Padma Sree Foods

B5) Bags of millet waiting for processing at Periayur Farmer Producer Organisation

B6) Focus group with members of Periayur FPO

B7) Sorghum fields and electric cables around Periayur FPO

B8) Periayur farmer near field of barnyard millet

B9) Koda millet growing near Periayur FPO

B10) Barnyard millet growing near Periayur FPO

B11) Millet processing machine provided to mill near Sengapadai by DHAN in phase one

B12) Some of the DHAN team with farmers near Periayur

B13) Sign outside the mill in Sengapadai detailing health benefits of millet

B14) Focus group with women in a village near Sengapadai

B15) Piped water to village near Sengapadai

B16) One of four daily bus services to village near Sengapadai

B17) Millet growing intercropped with pulses and other nutritious crops near Sengapadai

B18) The DHAN team near a field of a variety of barnyard millet not normally grown in Tamil Nadu (introduced from Karnataka in an earlier phase)

B19) Millet health-mix by Green House Food Products in sophisticated packaging improved with help from DHAN and batch coded

B20) Food supplies being stored in rat and pigeon-proof setting

B21) Green Happy Foods Millet cookies in eco-packaging with nutritional content analysis from TNAU

B22) Two kinds of millet cookies produced by Green Happy Foods – refined and unrefined sugar

B23) Small-scale production of millet cookies in the back of the print shop, Green Happy Foods.

B24)Mothi millet products husband and wife team

B25) Worker machining parts for AVM Engineering Industries, Salem

B26)AVM Engineering Industries sign advertising some of the millet dehullers

B27) The owner of AVM Engineering Industries with some of the DHAN team

B28)Leader of the DHAN Women's Federation in Salem and strong advocate of millet

B29)Focus group with some women from the Salem DHAN Women's Federation

B30) One of the owners of Victor Agro-Sales near his single-chamber millet dehuller with very smooth and quiet operation

B31) Prototype for a smaller model being developed by Victor Agro-Sales

B32) TNAU proposal to introduce millet into school feeding scheme of Tamil Nadu State

B33) TNAU poster on millet-based therapeutic foods developed in phase 2, and a poster on use of small millets in infant food

B34) Food analysis technician at TNAU lab where nutritional content and other food quality / safety tests are carried out

B35) Bakery at TNAU established during an earlier CIDA partnership

B36) Baking millet cookies in TNAU bakery

B37) Worker at Perfura Technologies

B38) Sales manager at Perfura Tech with a professor from TNAU

B39) Retired professor of TNAU who now runs a social enterprise involved in millet foodstuff production, Ramasami Chinnammal Trust

B40) Staff packaging vermicelli at Proteman Foods

B41) Vermicelli drying on tarpaulin in the sun at Proteman foods

B42) Owner at Shree Ganapathy Foods prepares millet coated mushrooms

B43)Millet powder mix of Shree Ganapathy Foods

B44)DHAN staff disussing with Shree Gaapathy owner outside their roadside shop